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e-Book

Inventory of CAU TECHNOLOGIES for NEH Region

Editors

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S. M. Haldhar
M. Premjit Singh

INVENTORY OF CAU TECHNOLOGIES FOR NEH REGION

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सत्यमेव जयते

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SECRETARY & DIRECTOR GENERAL

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FOREWORD

Central Agricultural University, Imphal, the first and also the largest agricultural University in terms of spread has been doing yeoman service to the farmers of the North East, India. With its diverse knowledge base and diversity of courses for the students offered at 13 colleges, 6 KVKs, 6 MTTCs and 6 VTCs located in all the states of North East India except Assam, the university has also developed an enviable research base and has been spreading its research findings through extension activities to the farmers. Recently, the University has also celebrated its silver jubilee which is a matter of pride for the first Central University in agriculture in the country.

The technology repository of the University is like a bank and one can draw for a solution to a given problem from this repository and apply for increasing the productivity of farm or farm-based enterprises. It is recommended from time to time to compile such technologies and make them available in the public domain. The present book entitled "**Inventory of CAU Technologies for NEH Region**" being published by the Central Agricultural University, Imphal is one of such initiative. I wish that the KVKs, MTTCs and VTCs will promote these technologies published in this book for addressing the problems of the region, and further verify the applicability of these technologies wherever necessary.

I compliment the Vice-Chancellor, CAU and entire team involved in compiling this publication for the benefit of the farmers and other stakeholders of the region. I also wish that more of such publications are brought out at regular intervals from Central Agricultural University, Imphal for the benefit of the farmers of North East India.

(T. MOHAPATRA)

Dated the 18th August, 2020
New Delhi

Dr. Anupam Mishra
Vice-Chancellor

CENTRAL AGRICULTURAL UNIVERSITY
IMPHAL, MANIPUR

FROM THE DESK OF VICE-CHANCELLOR

An institution's worth to society is gauged by the products that it gives to society. Agricultural universities are no exception to this yardstick. As agriculture is the prime occupation of our country, the role of agricultural universities is further accentuated by this scale. Central Agricultural University, Imphal in its existence of 27 years is dedicated to this important aspiration of the society.

This compilation is a document of 133 technologies developed, which definitely will positively impact the agricultural production scenario of North East of India. These technologies have been developed with local demands in mind, hence, can make a valuable contribution to the production and productivity of the land, but can impact the productivity of the other important sectors namely horticulture and animal husbandry including fisheries which are also as important to North East agriculture as much as the crop production itself.

This repository of technologies developed by Central Agricultural University, Imphal can be used as a ready reckoner for finding solutions for day to day problems in agriculture and allied sector, to provide solutions for value addition in all the fields of agriculture to augment additional income to the farmers as well as agripreneurs alike.

I congratulate the editorial team of this repository for taking the tall order to compile as well as the scientists of the University who have developed these technologies.

Let this be just the beginning as we can't be complacent with what we have achieved till now as it is said "everything can wait except agriculture" as agriculture will face newer and novel challenges asking the scientist to find equally novel and newer solutions.

(Anupam Mishra)

Preface

This book is a compilation of technologies that were developed by the different constituent colleges and the directorates of Central Agricultural University (CAU), Imphal. By far CAU, Imphal has the largest mandate area spanning seven states which represent diverse agroclimatic zones of the North East Region of India. To cater to these diverse regions' agricultural research requirements, the University has campuses to cater to all aspects related to agriculture, horticulture, veterinary, and animal sciences, fisheries, food science, and technology to look for the post-harvest management of agricultural produce and not to leave aside community development.

The unique ecological entity and topographical diversities are the exclusive characteristics of this North-East hill and mountain regions. Dominant features of hill farming namely small landholdings, sharp variations in altitude and ecology, sloppy land vulnerable to high soil erosion, and rainfall-dependence make it challenges it necessary to develop technologies specific to a microenvironment. Apart from this, a plethora of new challenges are also emerging.

During the recent past, weather patterns all over the world have changed and North-Eastern Himalaya is no exception. Agricultural production environment, being a dynamic entity, has kept evolving continuously. The present phase of changes being encountered by the agriculture and allied sectors such as gradually reducing the availability of quality water, nutrient deficiency in soils, climate change, farm energy availability, loss of biodiversity, the emergence of new pest and diseases, fragmentation of farms, rural-urban migration, new IPRs and trade regulations, are some of the new challenges.

Technologies that can contribute to an economically efficient farm sector and the financial viability for farmers while improving environmental performance and which are socially acceptable will provide "triple dividends" to sustainability. These location-specific technologies are required to be promoted and popularized among the farmers on a massive scale so that effective and wider diffusion of these technologies put forth a suitable strategy for ensuring the holistic and sustainable development of hill agriculture.

This **inventory includes the location-specific technologies developed/designed for the North-East Hill Region agriculture**, their importance, specifications, brief descriptions, benefits/advantages, and precautions. It is presumed that the introduction of these technologies if promoted well, will make meaningful contributions to improve the hill farm economy and make hill agriculture towards in the line of sustainability. **A number of these technologies are also available for licensing at a nominal price through MOU to help the entrepreneurs/farmers/NGOs.** We believe that this inventory will be of great use to researchers, extension personnel, research and development specialists in addressing the needs of farmers of hill

terrains and transform hill agriculture and allied sectors to new heights through proper diffusion of these frontier technologies as a catalyst of change through different extension functionaries viz., land-based departments, KVKs, MTTCs, NGOs, and others.

We extend our thanks to all the researchers of the Central Agricultural University, Imphal for providing details of the technologies developed by them for the compilation of this task in different phages and also acknowledge the help extended by the concerned Deans of the constituent colleges. We are thankful to Dr. M. Rohinikumar Singh and Dr. C. A. Srinivasamurthy, Former Directors of Research, and Dr. K. Noren Singh, Former Dy. Director of Research of CAU for their initial effort to compile the CAU technologies.

Further, we are also thankful to all other committee members comprising Dr. S. Basanta Singh, DI; Dr. Indira Sarangthem, Dean (COA); Dr. Y. Jekendra Singh, Dean i/c (CFT); Dr. K. Mamocha Singh, Registrar; Dr. L. Nabachandra Singh, Professor (COA); Dr. A. K. Mishra, Dy. DR constituted by the competent authority of the University for helping us in the initial stage to finalize the 'CAU Technologies' submitted by the constituent colleges to publish them as a technology inventory book.

The COVID- 19 pandemic and lockdown has given us an opportunity to devote ourselves to finalize the compilation work and ultimately, we succeed with the help of direct contact with all the contributors. The draft submissions were vetted by an expert committee to get feedback and suggestions before publishing. Therefore, the Editors are thankful to the committee constituted for vetting the contributions as well as experts namely Prof. A. C. Varshney, Ex-Vice Chancellor, UPPDDUPC Vishvavidyalaya Evam, Mathura; Dr. P. K. Srivastava, Ex-Dean, CAEPHT, Sikkim; Dr. K. K. Satapathy, Ex-Director, ICAR-NINFET; Dr. Chandish R. Ballal, Ex-Director, ICAR-NBAIR, Bengaluru; Dr. B. C. Deka, Director, ICAR-ATARI, Zone VII, Umiam; Dr. A. N. Ganeshmurty, Ex-Dean, COA, CAU, Imphal; Dr. A. K. Sahoo, Ex- Principal Scientist, CIFA, Bhubaneshwar; and Dr. R. Singh Rghuvanshi, Professor, College of Home Science, GBPUAT for helping us by providing their critical comments and valuable suggestions as experts for improving upon the individual technology and as a whole of this publication.

We extend our heartfelt thanks to Dr. S. Ayyappan, Chancellor, Central Agricultural University, Imphal for his keen interest and concern on the publication of farmers friendly technologies especially for the small and marginal farmers of the NEH Region. We indebted to Dr. Trilochan Mahapatra, Secretary (DARE, Govt. of India) and DG (ICAR, New Delhi) for providing us the 'Foreword' of this important publication of the University and also wish that at regular interval University should update such type of document/publication for the benefit of the farmers of this region. We also express our sincere gratitude to the present Vice-Chancellor, Dr. Anupam Mishra for his keen interest in compilation published as e-publication for wider use by all the stakeholders of this region in particular and, in the country as a whole. We are also publishing another publication compiling CAU technologies that can be commercialized.

The dream seen so far has now been converted into reality due to the valuable efforts of all the contributors/inventors, therefore, our sincere thanks are accorded towards all of them including all the Deans of the concerned colleges. Bringing out this book in the present shape has been possible due to the rigorous and continuous efforts of Mr. Y. Premchand Singh., Computer Operator and Smt. Narita L, PA to Director (EE) and others. We also thank the authorities of Central Agricultural University, Imphal for allowing to compile this compendium and providing financial resources to print this book with ISBN **978-81-938078-4-2**.

While utmost care has been taken to present in the correctness of different technologies, some omissions might have crept in and some errors might still have been left out uncorrected. We are confident that this publication will be an important source of information in the field of the stakeholders and extension functionaries devoted to the services of farming communities. It is also hoped that this compilation will be well received by the target audience and is open for any kind of suggestion, improvements so that future editions of this publication which we wish to make it a regular feature are even more user friendly.

Jai Kisan Jai Vigyan

R. K. Saha

E. V. D. Sastry

S. M. Haldhar

M. Premjit Singh

An Overview of Technology in Agriculture:
Development, Verification and Dissemination

R. K. Saha, E. V. D. Sastry
S. M. Haldhar, M. Premjit Singh

Technology (Greek word *technología*, "science of craft", "systematic treatment") is the branch of knowledge dealing with creations/ innovations/ inventions/ interventions/ processes/ methods/ devices/ procedures/ products/ materials, or the like and the use of technical means and their interrelation with life, society, and the environment, drawing upon such subjects as industrial arts, engineering, applied science, and pure science. Technologies are usually exclusively products of science, and also have to satisfy requirements such as utility, usability, and safety.

Technology in agriculture is any kind of intervention that is useful for the farmers in finding a solution to achieve higher productivity at a lower cost. Further, the term innovation comes from the association of two Latin words: "*in*", the same meaning as in English and "*novus*" = "new". It can mean a mere update or minor modification to a product, or revolutionizing it or inventing something totally new. In the former case, it would be referred to as an incremental (step by step) innovation, and in the latter, a radical innovation. Therefore, innovation is a broad concept, and can be defined as: "the introduction of new things, ideas or methods".

There can be no argument when one says that agriculture technology has transformed agriculture. Modern agriculture is the result of the amalgamation of different technologies that have been infused into agriculture. We do see distinct phases in agriculture development which are the result of the technology development. The 21st century is very dynamic in terms of the application of technology in agriculture leading to rapid development. The 1960s saw the green revolution as the result of the application of several technologies like modified plant architecture, use of synthetic fertilizers, and the use of chemicals in the control of pestilences. The seventies saw the development of chemical technologies to mitigate some of the effects of the early green revolution, particularly the control of weeds. The eighties saw the application of molecular and biotechnological tools to change the architecture within- the gene modifications, which led to the development of genetically modified plants/organisms, referred commonly as GMOs which changed the way the crop was managed. The GMOs have helped reduce the use of toxic chemicals controlling the pestilences, best examples are the bollworm control by the changed genetic makeup of the plant. Increasing the shelf life of tomatoes and so on. It also brought to the fore the debate on the ethical use of such technologies and also raised discussions on the effects of such modified plants on human health. While the debate is still on one can't ignore the promise these technologies have provided, they are used responsibly. The 21st century is witnessing the application of microelectronics and computers in increasing land productivity by effectively utilizing the natural resources and the applied resources. Good examples of such applications are the precision agriculture, satellite-based crop management systems and now the latest thing is big data analytics in improving land utilization and land productivity thereby increasing agricultural productivity. All these phases of technological revolutions in agriculture have one single objective- to provide human beings with the most basic requirement, the food in a sustainable way.

Each technology follows what is known as a cycle of research and development. It starts with synthesizing or theorizing a concept or idea which in turn is tested to explore its possible utility or clarify certain aspects leading to the design, develop and test the physical form of the concept. During the utilization of the technology so developed, the efficacy of the technology is tested and once it is found to be useful it is scaled up and side by side the effectiveness is also studied leading to the first step of the technology developed. It is best illustrated in **Fig. 1**.

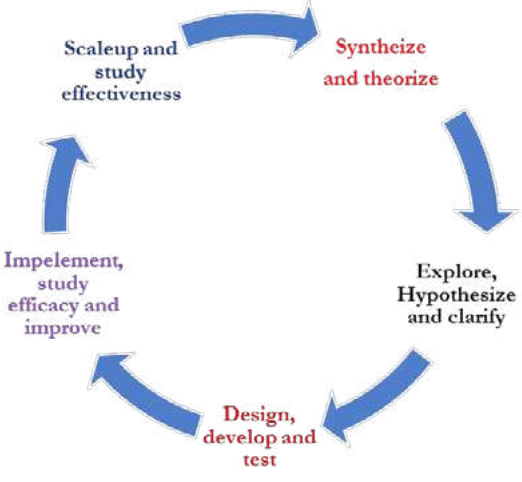

Fig. 1 Cycle of research and development

Each technology has a shelf life. In the early life a technology finds its application most, a time comes when the same technology is rejected for several reasons, either because of development of a new technology, or due to flaws of technology that are detected due to constant use, or the reduced or zero profits that technology offers in the changing times than when the technology was initially proposed. This is well illustrated in **Fig. 2**.

In agriculture also any technology follows a development cycle (**Fig. 3**) similar to what is shown in **Fig. 1**. A farmer communicates a problem that he faces to the scientist either directly or indirectly and when the solution is found the same is communicated to the farmer.

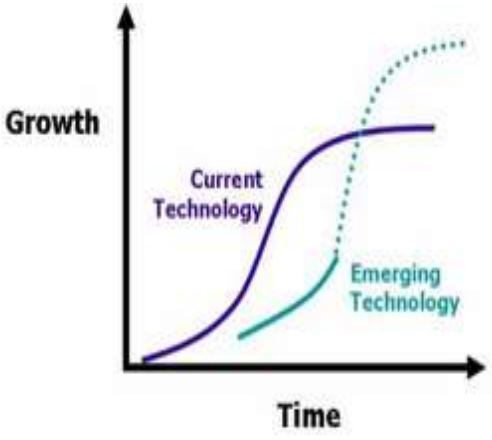

Fig. 2 Technology development curve

However, while it may look to be a direct channel for the technology's viability, it passes through different testing phases as shown in **Fig. 3**. Scientists also find solutions on their own on perceived problems even when the same is not communicated to them by farmers. The solution that is found by them is passed to farmers for adoption to address a potential problem, which may not have been faced by them in their routine professional activities. To test the efficacy of developed technologies of the University under different agro-climatic situations, the Central Agricultural University, Imphal has established "**Multi-Technology Testing Centers (MTTCs)**" which is a unique concept among the agricultural universities. So overall, different technologies on different aspects are developed by an agricultural institution. Agriculture, being dynamic, technology innovation is a continuous process. Each developed technology undergoes conceptualization- testing- scaleup (large scale adaption) and refinement cycle.

Each technology follows an interdependent technology development cycle called the technology cycle as depicted in **Fig. 4**. When a technology is developed and is adopted by the end-user, a new type of problem is faced which then follows the technology development cycle and gets a solution which

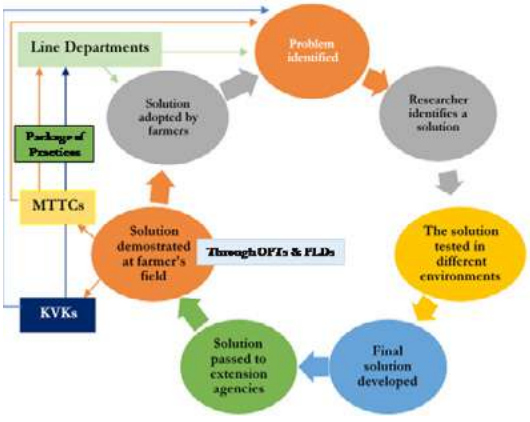

Fig. 3 Technology development and implementation cycle

in turn provides a new problem and so on, thus technology development is a continuous process. Sometimes a promising technology, when is presented to the end-user, may not find adaptability either because of the time lag between the identification of the problem and finding the solution or by the time a solution is found, a new and more potent problem is faced.

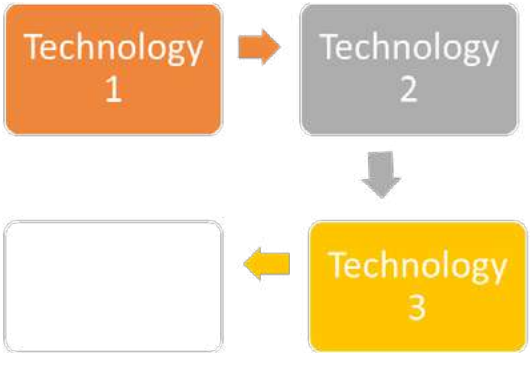

Fig. 4 Technology cycle

This present book is a compilation of technologies that were developed by Central Agricultural University, Imphal since its inception. Central Agricultural University, Imphal is unique among the agricultural universities of the country with a spread over 6 states of North East with varying geographic-climatic conditions.

To cater to these diverse regions' agricultural research requirements, the University has campuses to cater to all aspects related to agriculture, horticulture, agriculture engineering, veterinary and animal sciences, fisheries, food science and technology to look for the post-harvest management of agricultural produce and not to leave aside community development. The University at present has 13 colleges as well as 6 (six) KVKs to help and address the problems that farmers face in different aspects of agriculture. Also, these centers are expected to be a link between agricultural scientists located in colleges and farmers to disseminate the agricultural know-how and also get feedback to find solutions to new problems or fine-tune an existing solution for a given problem. Recently the University also established six (6) technology verification centers known as Multi-Technology Testing Centre (MTTC) in different states *viz.*, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Sikkim, and Tripura. It is expected that these centers will verify the new technologies developed by scientists at different locations for their adaptability so that technology is presented to the end-user- the farmer in the finest form for quick adoption thereby helping a farmer achieve more on his investment and thereby helping the country in furthering the sustainable development goals in agriculture and allied sciences. Not only MTTCs but also all the KVKs of North East India will play as a vital role by the active support of the ICAR-ATARI Zone VI (Guwahati) and VII (Umiam).

To give a unique identification to the technology developed by Central Agricultural University, Imphal, the technologies are identified by the name "**NECTAR**". The technologies developed by the University are presented in seven (7) broad groups namely, Crop Improvement (CI), Crop Management (CM), Crop Protection (CP), Animal Husbandry (AH), Aquaculture (AC), Farm Machinery (FM) and Post-Harvest Technology

(PHT). Due credit is given to the developers of the technology so that the developers may be contacted for any kind of query or suggested refinement regarding the technology. Many of the technologies have already been published or patented or under patenting. Hence, references to such aspects are also given to help the reader to know the status of the technology. Also, possible stakeholders of the technology are provided, so that the possible application and future course of action for the usage of the technology may be ascertained. As may be seen several of these technologies may require advanced testing for adoption at different zones than at the site of their development. Hence, the possible agencies which may use the technology are also presented for each of the technology. The agencies are, therefore, strongly advised to get the technology verified at the zonal KVKs or MTCCs. Each technology is also provided with references to know the authenticity or source of technology. It is expected that the technologies are first tested for adoption at the appropriate site so that the end-users, the farmers are first shown the technology so that the same is adopted by them.

A compilation like this is expected to find a quick solution thus saving a lot of economic and temporal constraints in finding solutions to a given problem in the field. It is expected that this will be a reference book to the extensions agencies and line departments for providing solutions for the problems posed by the farmers of their jurisdiction.

Further Reading

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INDEX

II. TECHNOLOGIES/PROTOTYPES/FARM TOOLS/METHODS/PRODUCTS

CROP MANAGEMENT (CM); TOTAL= 12

II. CROP MANAGEMENT (CM) TOTAL= 12	NECTAR-CM-10	Rapid macro-propagation techniques for banana	B. N. Hazarika	2011	23
	NECTAR-CM-11	Mass propagation of Kew pineapple	R. K. Dilip Singh and P. D. Mayengbam	2013	25
	NECTAR-CM- 12	Pruning guava (*Psidium guajava*L.) for winter cropin North-Eastern Indian condition	HauNgaih Lian and Barun Singh	2014	28
	NECTAR-CM-13	Wedge grafting in citrus	R. K. Dilip Singh and A. Thokchom	2015	30
	NECTAR-CM-14	Root-dipping in SSP-MC Slurry Method of P Management in rice-vegetable rotation	D. Thakuria	2015	33
	NECTAR-CM-15	CAU-*JHUM* Bioenhancer (Liquid biofertilizers for mixed crops of *Jhum* fields)		2016	36
	NECTAR-CM- 16	Influence of mulching on production potential and economic of rainfed rice-based cropping system	Edwin Luikham, K. S. Shashidhar	2017	39
	NECTAR-CM- 17	Biofortified Enriched Compost (BEC) for enhanced pulse productionin acid soil	D. Thakuria	2018	41
	NECTAR-CM- 18	Phosphorus recommendation for promising varieties of lentil	Edwin Luikhamand TophiaYumnam	2018	44
	NECTAR-CM- 19	Zinc fertilization for better growth and yield of tomato	Indira Sarangthem and Dasari Gopal	2018	46
	NECTAR-CM- 20	Optimum sowing time and integrated nutrient management for enhancing the yield of local glutinous maize	Edwin Luikham and TabuiliuAbonmai	2019	49
	NECTAR-CP- 21	Scientific cultivation of Arrowhead (*Sagittariasagittifolia*), an unexplored marshy-land crop	L. Nabachandra Singh	2019	51

III. CROP PROTECTION (CP) Total= 14					
III. CROP PROTECTION (CP) TOTAL= 14	NECTAR-CP- 22	Indigenous glue trap - an effective non-lethal tool for rodent management	M. Premjit Singh & K. I. Singh	1998	55
	NECTAR-CP- 23	Technology forStorage of planting material for effective management of rhizome rot of ginger	P. Raja	2009	57
	NECTAR-CP- 24	Mass production of *Trichoderma viride* a biocontrol agent	P. Raja	2010	59
	NECTAR-CP- 25	Mushroom cultivation technology for Arunachal Pradesh	R. C. Shakywar	2011	61
	NECTAR-CP- 26	Management and rejuvenation of citrus orchard of North East Region	R. C. Shakywar	2012	65
	NECTAR-CP- 27	Management of bacterial wilt of binjal, chilli and tomato in North East Region	M. Premjit Singh, Th. Robindro Singh, Nandini Chongtham & Th. Renuka Devi	2013	70
	NECTAR-CP- 28	Zero tillage cultivation of rapeseed-mustard with bee pollination and non-chemical method of plant protection	P. Raja	2013	73
	NECTAR-CP- 29	Mass production of plant growth promoting rhizobacteria agent for management of seed and soil borne disease of tomato, chilli, cabbage cauliflower and citrus.	Ph. Sobita Devi & Bireswar Sinha	2014	76
	NECTAR-CP- 30	Organic management of soft rot of ginger	B. N. Hazarika & S. Romen Singh	2014	78
	NECTAR-CP- 31	Techniques for production of virus free planting materials in *khasi* mandarin	M. Sumarjit Singh	2014	80
	NECTAR-CP- 32	Use of rice husk ash in controlling insects in stored soyabean seeds	Bireswar Sinha & Ph. Sobita Devi	2017	83
	NECTAR-CP- 33	Mass production of *Trichoderma* at low cost using agricultural waste	K. I. Singh and M. Premjit Singh	2018	85
	NECTAR-CP- 34	Insect trap with indigenous ash hen's feather and methyl eugenol for the control of fruit fly (*Bacteroceradorsalis*)		2020	87
	NECTAR-CP- 35	Integrated pest management in rainfed rice production system	M. Premjit Singh	2009/ 2020	89

IV. ANIMAL HUSBANDRY (AH) Total= 10					
IV. ANIMAL HUSBANDRY (AH) TOTAL= 10	NECTAR-AH- 36	Low cost housing system for quails	Lalnuntluangi Hmar, K. Lalrintluanga and M. C. Lallianchhunga	2007	93
	NECTAR-AH- 37	Early weaning and rebreeding in Large White Yorkshire pigs	Girin Kalita, Tridib Kumar Rajkhowa, Kalyan Sarma, Rajat Buragohain and Prasanta Saikia	2014	96
	NECTAR-AH- 38	Novel herbal formulation for the treatment of mange in pigs	Kalyan Sarma, Parimal Roy Choudhury, Sonjay Kumar Borthakur, Hridayesh Prasad and Rajat Buraghoin	2014	99
	NECTAR-AH- 39	Techniques of ejaculation and preservation of liquid semen of '*Zovawk*' for AI in pigs	F. A. Ahmed, K. Lalrintluanga and D. Talukdar	2014	102
	NECTAR-AH- 40	Homemade herbal feed additive to improve performance of pigs and poultry with total replacement of antibiotics	P. K. Subudhi	2016	104
	NECTAR-AH- 41	High value Manipuri poultry breed Kaunayen; best suited for local environment as sport activity	Th. Ranadhir Singh, P. K. Vij and M. S. Tantia	2016	107
	NECTAR-AH- 42	Process for preparing a novel herbal formulation for the treatment of piglet diarrhoea	SantanuGorai, Kalyan Sarma, Y. Damodar Singh and Gunjan Das	2017	111
	NECTAR-AH- 43	Adoptation oflocal pig of Mizoram "*Zovawk*" as recognized breed of India	N. S. Singh, A. K. Samanta, T. C. Tolenkhomba, K. Lalrintluanga and J. B. Rajesh	2018	114
	NECTAR-AH- 44	Utilization of palm oil sludge (POS) as pig feed	Temjennungsang, A. K. Samanta, B. K. Das, GirinKalita and M. Ayub Ali	2018	116
	NECTAR-AH- 45	Rapid detection of piglet diarrhea associated with Escherichia coli infection using polymerase spiral reaction (PSR) assay	T. K. Dutta, Belinda L. Vangchhia, P. Roychoudhury, Rebecca L. Ralte and P. K. Subudhi	2019	118

V. AQUACULTURE (AC) Total= 18

V. AQUACULTURE (AC) TOTAL= 18	NECTAR-AC- 46	Run-off water harvesting technology for upland fish- based farming system	J. R. Dhanze, R. K. Saha, M. K. Dattaand A. B. Patel	2012	123
	NECTAR-AC- 47	'Fish-rice-vegetable-fruit'based farming system	R. K. Saha, Dillip Nath and H. Saha	2014	129
	NECTAR-AC- 48	Profitable farming systemmodel of'fish-vegetable-fruit'	R. K. Saha,Dillip Nath and H. Saha	2014	134
	NECTAR-AC- 49	Farming system model on fish-vegetable-fruit-pig	R. K. Saha,Dillip Nath and H. Saha	2014	138
	NECTAR-AC- 50	Farming system model on fish-goat-fruit	R. K. Sah, Dillip Nath and H. Saha	2014	143
	NECTAR-AC- 51	Waste into wealth: Fish-mushroom farming system model	R. K. Saha, Dillip Nath and H. Saha	2014	146
	NECTAR-AC- 52	Utilization of detoxified rubber seed meal for fish feed formulation	Sharma, B. B., R. K. Saha and H.Saha	2014	149
	NECTAR-AC- 53	Seed production of zebra fish (Danio rerio) in aquarium condition	S. C. Mandal, M. K. Datta and A. B. Patel	2015	152
	NECTAR-AC- 54	Low cost seed production of Pabda (Ompokbimaculatus)	P. Biswas, R. K. Saha and P. K. Pandey	2015	155
	NECTAR-AC- 55	Floating grow-out supplementary carp feed: COF: CAU-GCFF	A. B. Patel, M. K. Datta and S. C. Mandal	2015	159
	NECTAR-AC- 56	Live Wolffia–based fingerling production of rohu (Labeorohita)	A. B. Patel, P. K. Pandey, A. Pradhan and H. Priyadarshi	2015	162
	NECTAR-AC- 57	Farming systemmodel 'water reed-fish-veg-fruit' as a profitable livelihood option	M. A. Salam, O. Gunajit, Ch. Nandini, R. K. Saha and M. Premjit Singh	2017	165
	NECTAR-AC- 58	Incorporation of Silver barb Barbonymusgonionotus (Bleeker) in feed-based seasonal carp polyculture pond system	A. B. Patel, M. K. Datta, and S. C. Mandal	2017	169
	NECTAR-AC- 59	Medicated feed for ameliorating the effect of low pH and waterborne iron stresses in fish	H. Saha, R. K. Saha and C. Laltlanmawia	2017	171
	NECTAR-AC- 60	Bamboo leaf extract based dietary formulation against multiple stresses in fish	H. Saha, R. K. Saha and Md. Idrish	2017	173
	NECTAR-AC- 61	CAU (Imphal)-BRSHTI: A low cost in-situ hatchery for carp seed production	H. Priyadarshi, R. Das, S. Prakash, A. A Singh, A. B. Patel and P. K. Pandey	2018	176
	NECTAR-AC- 62	Fish feed using protein concentrates and protein isolates from rubber seeds	H. Saha, R. K. Saha, N. P. Sahu and A. K. Pal	2018	179
	NECTAR-AC- 63	Organic piscicides for killing weed fishes in aquaculture pond	B. Chouriya, H.Saha and R. K. Saha	2018	182

VI. FARM MACHINERY (FM) Total= 42					
VI. FARM MACHINERY (FM) TOTAL= 42	NECTAR-FM- 64	Conversion of loose charcoal/ charcoal dust into usable fuel	A. K. Mishra and P.K. Srivastava	2010	187
	NECTAR-FM- 65	Animal drawn wing plough	R. K. Saha, Dillip Nath and H. Saha	2014	189
	NECTAR-FM- 66	Animal drawn single row zero till drill	S. K. Chauhan	2011	191
	NECTAR-FM- 67	Improved large cardamom harvesting knife	T. K. Khura, M. S. Seveda, S. N. Yadav and S. K. Rautaray	2011	193
	NECTAR-FM- 68	Multipurpose Biomass Griller for roasting fresh Maize Cobs and other vegetables	A. K. Mishra and P.K.Srivastava	2011	195
	NECTAR-FM- 69	Twin fixed dome biogas plant for cold hilly terrain of NEH		2011	198
	NECTAR-FM- 70	Improved multipurpose sigri/stove		2011	200
	NECTAR-FM- 71	Insulated biogas plant suitable for cold climate of Sikkim		2012	203
	NECTAR-FM- 72	Portable kiln for making charcoal from biomass		2012	206
	NECTAR-FM- 73	Low-cost gravity-based ropeway for transportation of agricultural produce and inputs	T. K. Khura, S. N. Yadav, S. K. Rautaray and M. S. Seveda	2012	208
	NECTAR-FM- 74	Portable side feed smokeless cook stove	A. K. Mishra andM. S. Seveda	2012	211
	NECTAR-FM- 75	Portable PV powered forced convection solar dryer	M. S. Seveda	2012	213
	NECTAR-FM- 76	Energy efficient double pot improved biomass cook stove		2013	216
	NECTAR-FM- 77	Portable biomass based forced hot air dryer	A. K. Mishra andP.K.Srivastava	2013	219
	NECTAR-FM- 78	Two rows manual rice transplanter	S. N. Yadav	2017	221
	NECTAR-FM- 79	Improved animal drawn wedge plough	S. K. Chauhan	2013	223
	NECTAR-FM- 80	Animal drawn multipurpose tool frame with attachment		2013	226
	NECTAR-FM- 81	Portable Biomass based forced hot air dryer	A. K. Mishra andP.K.Srivastava	2014	229
	NECTAR-FM- 82	Manual Honey Extractor	P. T. Sharma, Ng. Joykumar Singh and Y. JekendraSingh	2014	232
	NECTAR-FM- 83	Animal drawn single row improved Potato Digger	S. K. Chauhan	2014	234
	NECTAR-FM- 84	Animal drawn improved rolling peg type puddler		2014	237

VI. FARM MACHINERY (FM) TOTAL= 42	NECTAR-FM- 85	Animal drawn single row zero till planter	S. K. Chauhan	2015	240
	NECTAR-FM- 86	Adjustable saddle for transportation of pack load by yak		2015	242
	NECTAR-FM- 87	Animal drawn two row zero-till-planter for multi crop use		2015	245
	NECTAR-FM- 88	Power tiller operated multicrop seed drill cum planter	S. K. Satpathy	2015	247
	NECTAR-FM- 89	Animal drawn clod crusher, leveler cum planker	S. N. Yadav	2015	250
	NECTAR-FM- 90	Mixed mode photovoltaic powered forced convection solar dryer	M. S. Seveda	2015	253
	NECTAR-FM- 91	Solar Dryer	Ng. Joykumar Singh, P. T. Sharma and Y. Jekendra Singh	2015	256
	NECTAR-FM- 92	Low cost portable zero energy cooling chamber	P. T. Sharma, Ng. Joykumar Singh	2015	258
	NECTAR-FM- 93	Improved Kokcheng (bamboo basket)	Swapnali Borah	2015	261
	NECTAR-FM- 94	Improved harnessing system of domesticated Mithun for utilization in agriculture (YOKE)	S. K. Chauhan	2016	264
	NECTAR-FM- 95	Power operated hold-on type paddy thresher	S. K. Satpathy	2016	267
	NECTAR-FM- 96	Filtration units for natural streams for reducing the sediment load in natural ponds/ tanks	A. K. Vashisht	2016	270
	NECTAR-FM- 97	Portable manual mulch laying machine for hill terrace	Kh. Lily Devi and Deepak Jhajharia	2016	272
	NECTAR-FM- 98	Solar biomass hybrid dryer for large cardamom drying	M. S. Seveda	2017	274
	NECTAR-FM- 99	Light weight self-propelled zero till multi-crop planter	S. N. Yadav, S. R. Yadav and A. B. Sherpa	2017	276
	NECTAR-FM- 100	Self-propelled crop residue mulcher cum weeder		2017	278
	NECTAR-FM- 101	Ginger-Turmeric Washer	Ng. Joykumar Singh, P. K., Sarangi and Th. Anand Singh	2017	280
	NECTAR-FM- 102	Pineapple Peeler-cum-Corer-cum Slicer		2018	282
	NECTAR-FM- 103	Pineapple Harvester		2018	284
	NECTAR-FM- 104	Pony Driven Cart for Agricultural Farm	Th. Ranadhir Singh and P. T. Sharma	2018	286
	NECTAR-FM- 105	Makhana Harvester	Ng. Joykumar Singh, P. K., Sarangi and Th. Anand Singh	2019	290

VII. POST-HARVEST TECHNOLOGY (PHT) Total= 28

VII. POST-HARVEST TECHNOLOGY (PHT) TOTAL= 28	NECTAR-PHT- 106	Extruded snack from fish (Fish Kurkure)	R. K. Majumdar	2010	295
	NECTAR-PHT- 107	Packing technology for orchid cut flowers	A. I. Singh and Sujata Jena	2011	297
	NECTAR-PHT- 108	Blended RTS beverages using passion fruit, Sikkim mandarin and ginger	P. K. Srivastava and Sujata Jena	2011	299
	NECTAR-PHT- 109	Ready-To-Serve (RTS) pineapple juice- a value added product	Sujata Jena	2013	301
	NECTAR-PHT- 110	Retortable pouch processed ready-to-serve fish curry in North Eastern style	R. K. Majumdar and B. Dhar	2013	303
	NECTAR-PHT- 111	Smoked laminates from Pangasius fish	B. Dhar and R. K. Majumdar	2014	306
	NECTAR-PHT- 112	Pre-processing technique for reducing cyanide levels in bamboo shoot	A. Chakma and Y. Ranjana Devi	2014	308
	NECTAR-PHT- 113	Wadi as value added products from squash (Sechium edule)	P. Das and L. K. Mishra	2015	310
	NECTAR-PHT- 114	Squash (Sechium edule)Pickle as value added products	P. Das	2015	312
	NECTAR-PHT- 115	Osmo-dehydrated Pineapple products [Ring and Titbits]	Ng. Joykumar Singh, P. K. Sarangi, Th. Anand Singh	2016	315
	NECTAR-PHT- 116	Jackfruit Chips- a value added product	N.R. Marak and A. Kumar	2016	317
	NECTAR-PHT- 117	Jackfruit Squash- a value added product		2016	319
	NECTAR-PHT- 118	Jackfruit Papad- a value added product		2016	321
	NECTAR-PHT- 119	Ready-to-Cook (RTC) as value added products of jackfruit		2016	323
	NECTAR-PHT- 120	Aloe vera based RTS drink blended with ginger, amla and sweet lime	L. K Mishra	2017	325
	NECTAR-PHT- 121	Pineapple Ready-To-Serve (RTS) drink blended with ginger, Cinnamon	Ng. Joykumar Singh, P. K. Sarangi, Th. Anand Singh and P. T. Sharma	2018	328
	NECTAR-PHT- 122	Low glycemic index (GI) roti mix	N. R. Singh	2019	330
	NECTAR-PHT- 123	Low glycemic index (GI) upma mix		2019	332
	NECTAR-PHT- 124	Low glycemic index (GI) cheela mix		2019	334
	NECTAR-PHT- 125	Process protocol for preparation of pineapple powder with natural aroma	Ng. Joykumar Singh, P. T. Sharma and Y. Jekendra Singh	2019	336

Chapter - 1

CROP IMPROVEMENT (CI) 09 technologies

TECHNOLOGY:
NECTAR-CI- 01 (Paddy)

1. **Name of the technology/variety:** High yielding paddy variety CAU-R1(*Tamphaphou*)
2. **Source of the technology/variety:** DOR, CAU, Imphal, Manipur
3. **Year of release/notification of variety:** SVRC 1999/2009 for wetland and CVRC 2018/2018 for upland [1379(E) 27 April, 2018]
4. **Description of variety with salient features:**

a)	Parentage	Leimaphou x BR-1
b)	Duration	125-130 days
c)	Plant height	100 cm
d)	Area of adaptation	Rainfed, wetland paddy fields of Manipur valley as main *Kharif* (Rainy season) transplanted and broadcast sown paddy crop
e)	Maturity group	Medium (Under Manipur valley conditions)
f)	Resistance to lodging	Non-lodging
g)	Shattering/Threshing	Non-shattering/and difficult to thresh if grains are not fully filled
h)	Seed rate	i. Direct seeding in puddled soil- 60 kg ha^{-1} ii. Transplanted- 50 kg ha^{-1} iii. SRI- 5 kg ha^{-1} iv. ICM-16 kg ha^{-1}
i)	Levels of fertilizer application	High Performance under low applied fertilizer level of 60: 40: 40 kg ha^{-1}
j)	Spacing	50 hills m^{-2} (20 cm row to row and 10 cm plant to plant)
k)	Brown rice recovery	High brown rice recovery- 72%
l)	Tolerance	Rice blast, BLB, etc. under field condition and moderately susceptible in rice blast and BLB under controlled conditions
M)	Submergence tolerance	Can tolerate submergence up to 7 days
n)	Late sowing up to	Can be sown upto the end of July
o)	Reaction to diseases/ pests	(Under field conditions): Tolerant to rice gall midge (Under controlled conditions): Moderately tolerant to rice gall midge
p)	Disadvantages	High chaffy grains under higher level of nitrogen top dressing at reproductive stage
q)	Recent position	1st Position in crop competition under farmers field during *kharif* 2009 (8.8 t ha^{-1}) and *kharif* 2014-15 (12.3 t ha^{-1})
r)	Average yield	5-6 t ha^{-1} under lowland and 2.39 t ha^{-1} under upland condition
s)	Unit cost	Certified Seed @ Rs. 46 kg^{-1} (2020)

Fig. 1 CAU-R1 plants in the field

Fig. 2 CAU-R1 grains

Fig. 3 CAU-R1 rice

5. **Critical inputs required:** Certified Seed, Nitrogen and Potash
6. **Observation to be recorded:** Plant height (cm), duration and Yield (t ha^{-1})
7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs/Farmers
8. **Precaution(s) with the variety:** Seed treatment with carbendazim @ 1g kg^{-1} of seed. Nitrogen should be applied in three split doses, i.e., half of the total requirement as basal, one-fourth at tillering stage, and remaining one fourth at PI (Panicle Initiation) stage along with remaining potash.
9. **Advantage/Benefits/Utility of the variety:** Under proper management practices, the variety has the potential to yield an average of **5-6 t ha^{-1}**
10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 1.39 under conventional cultivation
11. **Technology/variety developed under the project:**

    Research outcome of the Department of Genetics and Plant Breeding, College of Agriculture, Central Agricultural University, Imphal.

12. **Investigator(s)/inventor(s):**

    M. Rohinikumar Singh, Ph. Ranjit Sharma, K. Noren Singh, M. Premjit Singh, Pramesh Kh. and Th. Renuka Devi proposal submitted for CVRC release & Notification.

13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C., Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 06: Technology No. 01: High yielding paddy variety CAU-R1: 219-220.

Ganeshmurthy, A. N., Singh, M. P., Saha, R. K., Sastry, E. V. D., Sharma, Ph. R., Singh, K. N., Singh, Th. R., Devi, Th. R. and Shashidhar, K. S. (2019). CAU R1 (*Tamphaphou*)- A variety developed by Central Agricultural University, Imphal has returned more than what is spent. *CAU Farm Magazine*, 9(4): 2-4. ISSN: 2279-0454.

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TECHNOLOGY:
NECTAR-CI- 02 (Paddy)

1. **Name of the technology/variety:** Short duration paddy variety CAU-R3 (*Mangalphou*)
2. **Source of the technology/ variety:** DOR, CAU, Imphal, Manipur
3. **Year of release/notification of the variety:** SVRC 2012/2020 [6 Jan, 2020 Sl. No. 22]
4. **Description of variety with salient features:**

a)	Parentage with details of its pedigree	**Female parent** - RCM-7 (evolved from the cross between Kalinga-II and Palman having a height of about 100 cm with a duration of 115 days and an average yield of 4.0 t ha^{-1}. **Male parent** - V20 B (A maintainer line of V20 A but having field resistance to most of the diseases and short duration of about 90 days with an average yield of 3.5 t ha^{-1}).
b)	Breeding objectives	To develop an early rice variety as contingency crop for pre-*kharif* and late- *kharif* conditions
c)	Specific areas of its adaptation/ adoption	Irrigated/rainfed valley areas of Manipur with an altitude from 750 to 950 m above MSL where *rabi* crop is to be grown.
d)	Recommended ecology	Irrigated/Rainfed valley areas with medium to high soil fertility, pre-*kharif* to late-*kharif* sowing with high density planting.
e)	Plant height Semi-dwarf	(85 cm)
f)	Range	80- 90 cm
g)	50% flowering	≤ 70 days in late-*kharif* and 90 days during pre-*kharif*
h)	85% maturity	≤ 95 days in late-*kharif* and 120 days during pre-*kharif*
i)	Maturity group (early, medium and late –wherever such classification exists)	Very early
j)	Reaction to major diseases (under field conditions)	i. Blast - moderately tolerant ii. Brown spot- moderately tolerant iii. Rice Tungro Virus (RTV)- Resistant
k)	Reaction to major pests (under field and controlled conditions including store pests)	i. Gall midge- Moderately tolerant ii. Stem borer- Moderately tolerant
l)	Average yield	4-5 t ha^{-1} in rainfed valley land
m)	Unit cost	Certified seed @ Rs. 46 kg^{-1} (2020)

Fig. 1 CAU-R3 plants in the field

Fig. 2 CAU-R3 grains

Fig. 3 CAU-R3 rice

5. **Critical inputs required:** Certified seeds, nitrogen fertilizer and weed free condition about 2 months from transplanting.

6. **Observation to be recorded:** Plant height (cm), duration and Yield (t ha^{-1})

7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs/ Farmers

8. **Precaution(s) with the variety:** High density planting with weed free condition during the early growth stage of the variety preferably within one month after transplanting. Seed treatment with carbendazim @ 1g kg^{-1} of seed. Nitrogen should be applied in three split doses, i.e., half of the total requirement as basal, one-fourth at tillering stage and remaining one fourth at PI (Panicle Initiation) stage along with remaining potash.

   This needs clarity we must mention how many interculture operations. It cannot be vague like this as number of such operations vary with farmers. We must recommend as it is done in CAU R1

9. **Advantage/Benefits/Utility of the variety:** Very early and photo insensitive nature made the variety advantageous for cultivation as contingency crop after possible natural calamity of early season flood/drought during *kharif* season. During normal season, it is better suited for multiple cropping to enhance farmers income with diverse crop or mono crop in a year.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 1.20 under conventional cultivation and enhanced farmer's income by multiple cropping.

11. **Technology/variety developed under the project:**

    Research outcome of the Department of Genetics and Plant Breeding, College of Agriculture, Central Agricultural University, Imphal.

12. **Investigator(s)/ inventor(s):**

    M. Rohinikumar Singh, K. Noren Singh, Ph. Ranjit Sharma, S. N. Puri, Th. Renuka Devi and Pramesh Kh.

12. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 06: Technology No. 03: Short duration paddy variety CAU-R3: 222-223.

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TECHNOLOGY:
NECTAR-CI- 03 (Paddy)

1. **Name of the technology/variety:** Semi-deep-water paddy CAU-R4 (*Eenotphou*)

2. **Source of the technology/variety:** DOR, CAU, Imphal, Manipur

3. **Year of release/notification of variety:** SVRC 2012/2020 [6 Jan, 2020 Sl. No. 13]

4. **Description variety with salient features:**

   CAU-R4 (***Eenotphou***) evolved from the cross between *Moirangphou khokngangbi* x *Leimaphou*. The variety matures within 145 days with good grain quality of Manipur's local preference with a milled rice recovery of about 68 percent. The variety withstands most of the diseases and insect pest of rice to a considerable extent. CAU-R4 performed well as a main paddy crop under low lying semi deep-water rice ecosystems prevailing in the periphery of lakes (*Patlou*) of Manipur valley and similar situations in the NEH Region. Some of the other details are as follows:

a) Plant height	145- 150 cm
b) Duration	140-145 days
c) Yield improvement (%) over (Check var. *Moirangphou khokngangbi*)	15%
d) Panicle characteristics	
i. Panicle length	32 cm
ii. Grains per panicle	200
iii. 1000-grain weight	29 g
e) Reaction to major diseases in the field	Moderately tolerant to blast and brown spot
f) Average yield	1.1-1.5 t ha^{-1}
g) Unit cost	Certified seed @ Rs. 46 kg^{-1} (2020)

5. **Critical inputs required:** Certified seeds, Nitrogen for top dressing in water - Slow release fertilizer N is not common in India. Hence this part may be deleted.

6. **Observation to be recorded:** Plant height (cm), water level (max. 50 cm), duration and yield (t ha^{-1})

7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs/ Farmers

8. **Precaution(s) with the variety:** Sowing and transplanting should be done well ahead before the onset of Monsoon season/rainy season. Whenever possible, the water level should be changed during the vegetative growth at least 2-3 times to avoid water soaked area on the particular spot of the stem. Give some clarity on water level

9. **Advantage/Benefits/Utility of the variety:** Specific adaptation in. low lying areas give the advantage for Paddy cum Fish culture, a dual income source of the farmer.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 1.19 as a mono crop of rice

Fig. 1 CAU-R4 plants in the field

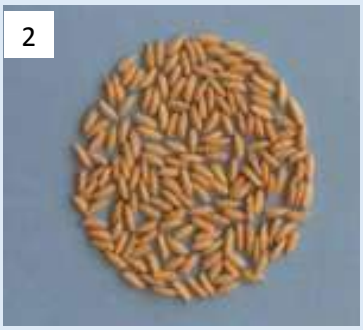

Fig. 2 CAU-R4 grains

Fig. 3 CAU-R4 rice

11. Variety developed under the project: Research of the Department of Genetics and Plant Breeding, College of Agriculture, Central Agricultural University, Imphal

12. Investigator(s)/inventor(s):

M. Rohinikumar Singh, K. Noren Singh, Ph. Ranjit Sharma, S. N. Puri, Th. Renuka Devi and Pramesh Kh. proposal submitted for CVRC release & Notification.

13. Technology publication(s):

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 06: Technology No. 04: Semi-deep-water paddy CAU-R4: 223-224.

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TECHNOLOGY:
NECTAR-CI- 04 (Paddy)

1. **Name of the technology/variety:** Upland paddy variety CAU-R2 (*Tomthinphou*)
2. **Source of the technology/variety:** DOR, CAU, Imphal, Manipur
3. **Year of release/notification of variety:** SVRC 2016/2020 [6 Jan, 2020 Sl. No. 14]
4. **Description of variety with salient features:** The variety is an early maturing type suitable for rainfed upland and *jhum* ecosystem condition with high organic matter content.

a)	Parentage	Cauvery x V20-B Female parent: Cauvery (TN-1x TKM-6) Male parent: V20B (a Chinese short duration semi-dwarf rice variety)
b)	Breeding method	Modified Pedigree with single panicle descent method.
c)	Adaptation	Upland and *Jhum* ecosystem
d)	Plant stature	Semi dwarf (80 cm)
e)	Yield improvement (%) over Local check	40% - 50%
f)	Maturity group	Extra early (95-100 days)
g)	Panicle characteristics i. Panicle length ii. Grains per panicle	 20 cm 100
h)	1000-grain weight	28 g
i)	Levels of fertilizer application	High performance under low applied fertilizer level of 60: 40: 30 kg ha^{-1}
j)	Average rice yield	2.0 t ha^{-1}
k)	Unit cost	Certified Seed @ Rs. 46 kg^{-1} (2020)

5. **Critical inputs required:** Nitrogen and organic matter content
6. **Observation to be recorded:** Plant height (cm), duration and yield (t ha^{-1})
7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs/ Farmers
8. **Precaution(s) with the variety:** The soil should have high organic matter content for good water holding capacity and the field should be free from weeds for at least two months.
9. **Advantage/Benefits/Utility of the variety:** The variety has yield advantage of 50% with earliness than local at the time of testing and development in Manipur.

Fig. 1 CAU-R2 plants in the field

Fig. 2 CAU-R2 grains

Fig. 3 CAU-R2 rice

10. **Economics of the technology/ Benefit: Cost Ratio:** 50% more yield in less time only 3 months

11. **Technology/variety developed under the project:** Research outcome of the Department of Genetics and Plant Breeding, College of Agriculture, Central Agricultural University, Imphal.

12. **Investigator(s)/inventor(s):**

    M. Rohinikumar Singh, K. Noren Singh, Ph. Ranjit Sharma, M. Premjit Singh, N. Anando Singh, Th. Renuka Devi and Pramesh Kh. proposal submitted for CVRC release & Notification.

13. **Technology publication:**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 06: Technology No. 02: Upland paddy variety CAU-R2: 221.

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TECHNOLOGY:
NECTAR-CI- 05 (Groundnut)

1. **Name of the technology/variety:** Promising line of groundnut "CAU-GS1"
2. **Source of the technology/variety:** DOR, CAU, Imphal, Lamphelpat, Manipur
3. **Status of the variety/line:** Testing of the genotype has already completed two years of testing under code ISK-I-2017-8 in all India coordinated trails.
4. **Description variety/line with salient features:**

   CAU-GS1 is a promising line with high yield potential under good management conditions. The genotype has an average kernel yield of 3.2 t ha^{-1} with plant height ranging between 45-50 cm and maturing in 130 days. The variety has approximately 45% oil content and is resistant to late leaf spot diseases. The leaves of the variety are green at maturity which can be used as fodder.

a)	Parentage	ICGV 01352 (female) x ICGX 010052 (male)
b)	Breeding method	Single Seed descent method.
c)	Adaptation	Foothills/ Upland with friable soil structure
d)	Plant Stature	45-50 cm
e)	Yield improvement (%) over (Check var.)	7% increase over best check (The genotype **CAU-GS1** recorded mean yield of 3293 kg ha^{-1} whereas the best check i.e., genotype **R 2001-2,** recorded mean yield of 3083 kg ha^{-1} over two years/seasons, in coordinated trials at CAU, Imphal centre).
f)	1000-grain weight	450 g
g)	Levels of fertilizer application	Application of fertilizers in the ratio of 20:40:60 NPK
h)	Average kernel yield	3.2 t ha^{-1}

5. **Critical inputs required:** Lime, NPK

6. **Observation to be recorded:** Plant height (45-50 cm), duration 125 days and yield (3.0 to 3.3 t ha^{-1})

7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs

8. **Precaution(s) with varity/line:** In Manipur condition, application of lime @ 500 kg ha^{-1} is recommended for growth of the crop.

9. **Advantage/Benefits/Utility of the variety/line:** The variety exhibited 22% higher yield over local check and 7% over best zonal check) in two years IVT trials

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 2.0

11. **Technology developed under the project:** ICAR-AICRP (Groundnut), CAU, Imphal

12. **Investigator(s)/inventor(s):** Pramesh Kh.: Email: prameshkh@gmail.com; Mobile: 9856091701

13. **Technology publication(s):**

Anon. (2019). Annual Groundnut Workshop- 2019, Annual Report (*kharif* 2018), pp. PB-59.

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TECHNOLOGY:
NECTAR-CI- 06 (Indian mustard)

1. **Name of the technology/variety/line:** CAU RM-1 a promising high yielding line of Indian mustard: *Brassica juncea* (IVT. No. MCN (E) -17-20)
2. **Source of the technology/variety/line:** DOR, CAU, Imphal, Manipur
3. **Year of release of the variety/line:** 2018
4. **Description of variety/line with salient features:** CAU-RM 1 (Indian mustard) is a promising line developed from a cross between [NRCIJ47 X NRCIJ36 (4-8-2)] and BPR-547-2 through pedigree method of breeding. This promising line attained average plant height of 150 cm and early maturing with mean seed yield of about 1945 kg ha^{-1} when tested under Ludhiana, Navgaon, New Delhi, Hisar, Abohar and Chatha Centres during 2017-18. It has 40.5% oil content and 794 kg ha^{-1} total oil yield. It is tolerant to white rust and suitable under rainfed rice fallow conditions of Manipur state.

a)	Parentage	[NRCIJ47 x NRCIJ36 (4-8-2)]- Used as female parent, an extra early white rust resistant genotype obtained from DRMR, Bharatpur BPR-547-2- Used as male parent, a high yielding drought tolerant genotype obtained from DRMR, Bharatpur
b)	Duration	115 days with optimum sowing time during 1st fortnight of November
c)	Plant height	150 cm
d)	Area of adaptation	Rainfed wetland paddy fields of Manipur valley and foot hills and other similar situations of NEH region
e)	Maturity group	Early
f)	Resistance to lodging	Non-lodging
g)	Shattering/Threshing	Non-shattering
h)	Seed rate	i. 12 to 14 kg ha^{-1} for zero tillage surface seeding ii. 8 to 10 kg ha^{-1} for conventional tillage
i)	Levels of fertilizer application	80 : 30 : 30 kg ha^{-1} for conventional tillage 2/3rd of the recommended dose under zero tillage
j)	Spacing	30 cm row to row 10 cm plant to plant
k)	Tolerance	Tolerant to white rust
l)	Yield	1945 kg ha^{-1} (Average Zone-II) 688 to 1045 kg ha^{-1} under zero tillage

Fig. 1 CAU-RM1 at seed production plot

Fig. 2 CAU-RM1 at farmer's field

5. **Critical inputs required:** Quality seed, nutrient management (NPK).
6. **Observation to be recorded:** Soil moisture, nutrient content of the soil, plant height (cm), duration and Yield (t ha^{-1})
7. **Target users/stakeholders:** MTTCs/ KVKs
8. **Precaution(s) with the variety/line:** Adequate Plant population and proper crop management
9. **Advantage/Benefits/Utility of the variety:** The variety exhibited increased yield percentage over local by at least 31%.
10. **Economics of the technology/ Benefit: Cost Ratio:** 1:2.29 for zero tillage & 1:2.54 for conventional tillage
11. **Variety/line developed under the project:**

    ICAR- All India Co-ordinated Project on AICRP on Rapeseed-Mustard, Central Agricultural University, Imphal Centre**.**
12. **Investigator(s)/ inventor(s):**

    Th. Renuka Devi, Pushparani Senjam, Diana Sh. Email: renukath2002@yahoo.co.in; Mobile: 09612170247.
13. **Technology publication(s):**

    Anon. (2018). Annual Report 2017-18 of ICAR- All India Co-ordinated Project on AICRP on Rapeseed-Mustard, Directorate of Rapeseed-Mustard Research, Bharatpur.

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Director of Research, Central Agricultural University (Imphal), Lamphelpat, Imphal 795 004 Manipur; Email: dorcau@gmail.com

TECHNOLOGY:
NECTAR-CI- 07 (Toria)

1. **Name of the technology:** Promising line of Toria "CAU-Toria 1" (IVT No. TCN-18-5)
2. **Source of the variety/line:** DOR, CAU, Imphal, Manipur
3. **Year of release of variety/line:** 2019
4. **Description of variety/line with salient features:**

   CAU-Toria 1 is a promising toria line developed through composite breeding programme with base variety M-27 and TS-36 and maintained by mass selection. This promising line attains an average plant height of 80 cm and maturing early (100 days duration) with average seed yield of about 1327 kg ha^{-1} (range from 649 to 2985 depending on soil fertility and crop management). The seed contains 42% oil with total oil output of 557 kg ha^{-1}. It is tolerant to white rust but moderately susceptible to *Alternaria* blight.

a)	Parentage	M-27 and TS-36
b)	Duration	86 to 111 days (All India)
c)	Plant height	80 cm
d)	Area of adaptation	Rainfed wetland paddy fields of Manipur valley and foot hills
e)	Maturity group	Early
f)	Resistance to lodging	Non-lodging
g)	Shattering/Threshing	Non-shattering
h)	Seed rate	i. 12 to 14 kg ha^{-1} for zero tillage surface seeding ii. 10 kg ha^{-1} for conventional tillage
i)	Levels of fertilizer application	60 : 30 : 30 kg ha^{-1} for conventional tillage 2/3rd of the recommended dose under zero tillage
j)	Spacing	30 cm row to row 10 cm plant to plant
k)	Tolerance	Tolerant to white rust but moderately susceptible to alternaria blight.
l)	Yield range (Zero tillage to conventional tillage)	649 – 2985 kg ha^{-1} depending on soil fertility and crop management


Figs. 1 to 3 Breeder seed production of variety CAU- Toria 1

5. **Critical inputs required:** Quality seed, nutrient management (NPK).
6. **Observation to be recorded:** Soil moisture, nutrient content of the soil, plant height (cm), duration and Yield (t ha^{-1})
7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs/ Farmers
8. **Precaution(s) with variety/line:** Adequate Plant population and proper crop management
9. **Advantage/Benefits/Utility of the variety/line:** The variety exhibited 25.78% over zonal check (Bhawani), 30.74% over Latest Release (Tapeswari) and at par with the National Check PT-303.
10. **Economics of the technology/ Benefit: Cost Ratio:** 1:2.08 for zero tillage and 1:2.42 for conventional tillage.
11. **Variety/line developed under the project:** All India Co-ordinated Project on AICRP on Rapeseed-Mustard, Central Agricultural University, Imphal Centre.
12. **Investigator(s)/inventor(s):**

    Th. Renuka Devi, Ps. Mariam Anal, N. Ingojaoba Singh**:** Email: renukath2002@yahoo.co.in; Mobile: 09612170247.
13. **Technology publication:**

    Anon. (2019). Annual Report 2018-19, Directorate of Rapeseed-Mustard Research, Bharatpur.

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TECHNOLOGY:
NECTAR-CI- 08 (Paddy)

1. **Name of the technology/variety/line:** Improved line CAUS 105(IET27496) of paddy

2. **Source of the variety/line:** CPGS-AS (CAU, Imphal), Umiam, Meghalaya

3. **Year of release of variety/line:** Presently under advanced testing in All India trials (2019)

4. **Description of variety/line with salient features:**

   CAUS 105 (IET27496) is a high yielding improved pure line derived from a cross between Shahsarang and Priya. The line carries PsTol1 gene, henceis suitable for phosphorus deficient acidic soil conditions. The line is suitable under low fertilizer input and organic cultivation practices. The line possesses resistance to leaf and neck blast.

a)	Parentage	Shahsarang x Priya
b)	Breeding method	Pedigree method
c)	Adaptation	Mid hill, lowland/wetland acidic soils
d)	Plant Stature	94.4 cm, compact, erect
e)	Yield improvement (%) over (Check var. CAUR-1)	10-15 %
f)	Maturity group	Medium maturity (139 days)
g)	Panicle characteristics	
	i. Panicle length	25.9 cm
	ii. Grains per panicle	200
h)	1000-grain weight	23.96
i)	Levels of fertilizer Application	
j)	Average Rice Yield	4.2 t ha^{-1} (Average of 5 locations and 2 years)

5. **Critical inputs required:**Nitrogen in the form of FYM or urea as per requirement and local recommendation.

6. **Observation to be recorded:** Plant height (cm), duration and Yield (t ha^{-1})

7. **Target users/stakeholders:** MTTCs/ KVKs

8. **Precaution(s) with the technology:** Nursery should be sown as thinly as possible to ensure vigorous seedling growth. Line transplanting with spacing 20 x 15 cm.

9. **Advantage/Benefits/Utility of the variety/line:** The line has high

Fig. 1 CAUS 105 (IET 27496) in the field

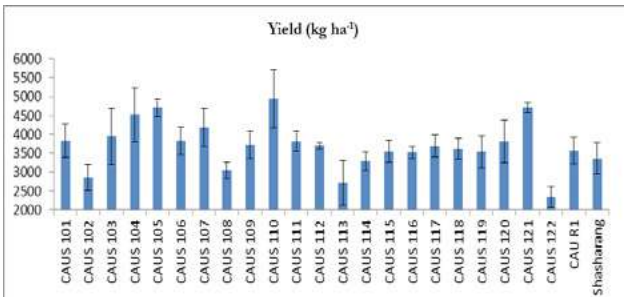

Fig. 2 Comparative performance of improved purelines as compared to checks (CAU R1 and Shahsarang) under low P lowland acidic soil condition

phosphorus use efficiency, and is suitable for phosphorus deficient acidic soil conditions. The line is suitable for low fertilizer input and organic cultivation practices. The line possesses resistance to leaf and neck blast.

10. **Economics of the technology/ Benefit: Cost Ratio**: NA

11. **Variety/line developed under the project:**

    ICAR-AICRPAVT, CPGS-AS, CAU (Imphal), Umiam, Meghalaya.

12. **Investigator(s)/ inventor(s):**

    Mayank Rai, Wricha Tyagi, Devyani Sen, Noren Singh, Tombisana Meetei: Email: mrai.cau@gmail.com; Mobile: 9436336008.

13. **Technology publication(s):**

    Anon. (2019). Proceedings of 6thHill Rice Workshop, SKUAST, Kashmir. 16th February, 2019, Vol. 1, Varietal Improvement. ICAR- All India Coordinated Rice Improvement Project.

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TECHNOLOGY:
NECTAR-CI- 09 (Paddy)

1. **Name of the variety/line:** Improved line CAUS 107(IET28210) of paddy
2. **Source of the variety/line:** CPGS-AS (CAU, Imphal), Umiam, Meghalaya
3. **Year of release of variety/line:** Under AICRP AVT 1 trial (2020)
4. **Description of variety/line with salient features:**

   CAUS 107 (IET28210) is a high yielding improved pure line derived from a cross between Shahsarang and CAUR-1. It has semi-glutinous endosperm. The line has high zinc content (28 ppm) in unpolished grain and is suitable for phosphorus deficient acidic soil conditions. The line is suitable under low fertilizer input and organic cultivation practices. The line possesses resistance to leaf and neck blast.

a)	Parentage	Shahsarang x CAUR-1
b)	Breeding method	Pedigree method
c)	Adaptation	Mid hill, lowland/wetland acidic soils
d)	Plant Stature	97.3 cm, compact, erect
e)	Yield improvement (%) over (Check var. CAUR-1)	12-15 %
f)	Maturity group	Medium maturity (126 days)
g)	Panicle characteristics	
	i. Panicle length	29.8 cm
	ii. Grains per panicle	220
h)	1000-grain weight	22.16
i)	Levels of fertilizer Application	As per soil condition
j)	Average Rice Yield	4.3 t ha^{-1} (Average of 5 locations and 2 years)

Fig. 1 CAUS 107 (IET 28210) in the field

5. **Critical inputs required:** Nitrogen in the form of FYM or urea as per requirement.
6. **Observation to be recorded:** Plant height (cm), duration and Yield (t ha^{-1})
7. **Target users/stakeholders:** MTTCs/ KVKs
8. **Precaution(s) with the variety/line:** Nursery should be sown as thinly as possible to ensure vigorous seedling

growth. Line transplanting with spacing 20 x 15 cm.

9. **Advantage/Benefits/ Utility of the variety/ line:** The line has high zinc content (28 ppm) in unpolished grain and is suitable for phosphorus deficient acidic soil conditions. The line is suitable for low fertilizer input and organic cultivation practices. The line possesses resistance to leaf and neck blast.

10. **Economics of the technology/ Benefit: Cost Ratio:** NA

11. **Variety/line developed under the project:** ICAR-AICRPAVT, CPGS-AS, CAU (Imphal), Umiam, Meghalaya.

12. **Investigator(s)/ inventor(s):**

    Mayank Rai, Wricha Tyagi, Devyani Sen, K Noren Singh, Tombisana Meetei: Email: mrai.cau@gmail.com; Mobile: 9436336008.

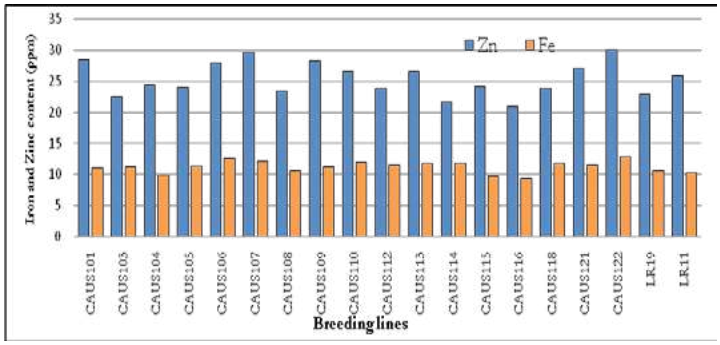

Fig. 2 Iron and Zinc content in unpolished grains of improved pure lines and Checks- LR19: CAU-R1; LR11: Shahsarang

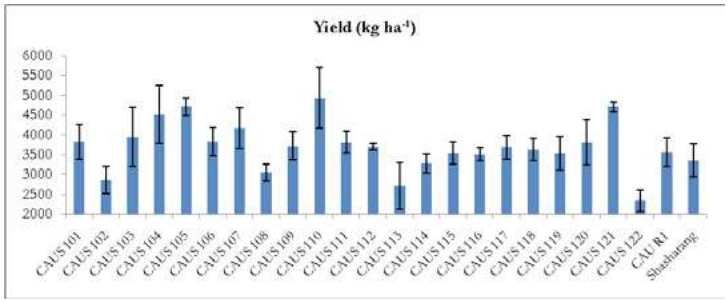

Fig. 3 Comparative performance of improved pure lines as compared to checks (CAU R1 and Shahsarang) under low P lowland acidic soil condition

13. **Technology publication(s):**

Anon. (2020). Proceedings of 7th Hill Rice Workshop, IIRR, Hyderabad. 19th February, 2020, Vol. 1, Varietal Improvement. ICAR- All India Coordinated Rice Improvement Project.

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Chapter - 2

CROP MANAGEMENT (CM) 12 technologies

TECHNOLOGY:
NECTAR-CM-10

1. **Name of the technology:** Rapid macro-propagation techniques for banana

2. **Source of the technology:** CHF(CAU, Imphal), Pasighat, Arunachal Pradesh

3. **Year of adoption/ development:** 2011

4. **Description of technology with salient features:**

   Banana is conventionally propagated by sword sucker. But the mother plant produces only few suckers as natural regeneration is very slow in banana due to hormone mediated apical dominance of mother plants. On the other hand, micro-propagation or *in vitro* propagation is a suitable method for rapid production of banana planting materials but it requires sophisticated techniques and skill making them generally out of reach of most of the marginal farmers. In this context,macro-propagation is a farmer-friendly technique, suitable for adoption by small and marginal farmers.

   Mother plant of desired variety is selected which are free from any disease more particularly bunchy top. There are two types of sucker produced from mother plant of banana *viz*.,sword sucker and water sucker. Sword sucker of about three-month-old with stout base should be selected. Sword sucker is removed with their rhizome from the mother plant and then it is decapitated with sharp knife at the base and leaf sheath attached to rhizome are removed carefully so that eye bud in rhizome are not disturbed. Then rhizomes are surface sterilized with fungicide solutions and splitted or decortication of corm is done. After that it is placed in media for spouting under shade. This method results in production of 9-15 uniform shoots/plants in a short span of time, roughly within 1- 3 months.

   Banana variety tested: Robasta (AAA), Dwarf Cavendish(AAA), Poovan (AAB)

   Media used: Ricehull, Sawdust, Cocopeat, Vermicompost

   The media ricehull, sawdust, cocopeat and vermicompost had almost similar effects on most of the sucker plantlet initiation parameters. However,the sucker plantlet emergence took longest time in vermicompost when used as the initiation media. Ricehull showed earliest sucker plantlet emergence compared to the other initiation media. The time taken for the emergence of the second plantlet was similar in case of both sawdust and cocopeat. The genotype Poovan was fastest in the plantlet emergence whereas Robusta took longest duration for emergence of plantlet. Dwarf Cavendish had shorter duration than the genotype Robusta to the emergence of the plantlet. More than 70% of Poovan plantlets initiated in sawdust had roots which stood highest compared to the other genotypes. Variability in the growth indices of the three Musa varieties showed significant by genotype interaction on all the growth parameters measured. Growth parameters were generally highest (irrespective of the varieties) when plantlets where raised in Ricehull + FYM than other media.

5. **Critical inputs required:** Sword sucker of banana, Sharp knife, Media, Shade house

Fig. 1 Decapitation and splitting of rhizome

Fig. 2 Rice hull, Sawdust, Cocopeat, Vermicompost as media

Fig. 3 Sucker emergence

Fig. 4 Sucker ready

6. **Observation to be recorded:** Observation on emergence of shoot per sucker need to be recorded.

7. **Target users/stakeholders:** MTTCs/ KVKs/Farmers

8. **Precaution(s) with the technology:** Precaution must be taken in selection of sucker. Sword suckerof 3-4 leaves should be collected from disease free mother plant with rhizome. After putting in media rotted rhizome if any should be removed immediately.

9. **Advantage/Benefits/Utility of technology:** This is a farmer's friendly technique without sophisticated technique, skill and care to handle which does not require much expertise and it is suitable for adoption by small and marginal farmers.

10. **Economics of the technology/Benefit: Cost Ratio:** 1:4.5

11. **Technology developed under the project:** Technology developed was with existing facility.

12. **Investigator(s)/inventor(s):** B.N. Hazarika: Email:bnhazarika13@yahoo.co.in; Mobile: 7005108240

13. **Technology publication(s):**

Hazarika, B. N. (2011). Macro propagation-A farmer friendly technique of propagating banana, *CAU Farm Magazine*, **1**(4): 7-8

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TECHNOLOGY:
NECTAR-CM-11

1. **Name of the technology:** Mass propagation of Kew pineapple
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Manipur
3. **Year of adoption/ development:** 2013
4. **Description of technology with salient features:**

Mass propagation of pineapple by tissue culture technique is a potential technology which serves as best alternative method over the traditional propagation by suckers, leading to production of large numbers of disease free, uniform planting materials in a relatively short period of time.

Explant preparation: Crowns of Kew pineapple are used as the source of explants. For explants preparation, the leaves from the crowns are first removed carefully and washed under running water for 5-10 mins. The terminal growing point of 1.5 cm diameteris removed from the crown and placed in a beaker after washing thoroughly in distilled water.

Media preparation: Murashige Scoog media (HI media) is used as the basal media with pH maintained between 5.7-5.8. Then, the media issterilized by autoclaving at 121°C and 1.5 kg cm^{-2} for 20 mins. After cooling down, filter sterilized hormone supplements (Benzyl adenine and Naphthalene acetic acid)are added. The media is poured into sterile culture jars (20ml each) under the laminar airflow chamber.

***In vitro* explant sterilization, inoculation and culture conditions**: The explants are washed thoroughly under running tap water to remove any field dirt. Under laminar airflow chamber, the explants are soaked in Bavistin for 15 mins, then washed thoroughly with water for 3-4times. The explants are then treated with 0.1% $HgCl_2$ for 5 mins followed by rinsing thoroughly in distilled water for 3-4 times. The explants are trimmed down to 0.5 cm and inoculated into culture jars containing the media. Sub-culturing is done at 15 days interval, on fresh media for every treatment. The cultures are incubated at a constant temperature of 25°C, relative humidity of 60-70% and photoperiodic regime of 16 hd^{-1} provided by fluorescent light (2800 lux intensity). Rooted plantlets are planted in sterilized river sand soil medium and proceeded

Fig. 1 Preparation of explant

Fig. 2 Sterilization

Fig. 4 Shoot initiation

Fig. 5 Shoot multiplication

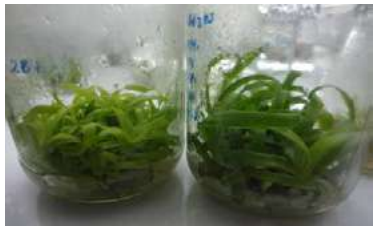

Fig. 6 Shoot elongation

Fig. 7 Rooting

Fig. 8 Acclimatization under polyhouse

Fig. 9 *In vitro* plantlets in field

for hardening. The period from the time of inoculation to production of rooted plantlets is about 130-140 days. The rooted plant need hardening before they can be transferred to field. The potted plantlets are kept first in polyhouse, then in shadehouse for 15 days each. The acclimatized *in vitro* seedlings are finally transplanted in the field.

5. **Critical inputs required:** MS media, Clarigel, plant growth hormones, $HgCl_2$, Sucrose, Bavistin, other basic plant tissue culture equipments and river bed soil

6. **Observation to be recorded:**
   - Number of shoots
   - Number of leaves
   - Shoot length
   - Number of roots
   - Root length

7. **Target users/stakeholders:** MTTCs/ KVKs/Entrepreneurs

8. **Precaution (s) with the technology:** Strict maintenance of sterilized condition is important in plant tissue culture. Regular observation must be taken to check any microbial contamination in the cultures. Timely sub-culturing should be done for better multiplication of the cultures and supplement with fresh nutrients uninterruptedly. While hardening, the media residues have to be washed out properly before planting in soil medium.

9. **Advantage/ Benefits/ Utility of technology:** This technique can help to supply large numbers of disease free, uniform pineapple planting materials in a relatively short period of time. Entrepreneurs, nursery growers and sellers can profit from this technology in their businesses. And farmers can be benefitted with the provision of healthy planting materials.

10. **Economics of the technology/ Benefit:** 1: 5.69

11. **Technology developed under the project:** Under PFDC, Imphal Centre, Horticultural Research Farm, Andro.

12. **Investigator(s)/inventor(s):**

    R. K. Dilip Singh and P. D. Mayengbam; Email: rkdsingh59@gamil.com; Mobile: 9402882753.

13. **Technology publication(s):**

    Mayengbam, P. D. and Dilip Singh, R. K. (2016). Effect of different levels of BAP on *in vitro* culture of pineapple (*Ananas comosus* L. Merr) var. Kew. *J. Interacad.*, **20**(4): 441-447.

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TECHNOLOGY:
NECTAR-CM-12

1. **Name of the technology:** Pruning guava (*Psidium guajava* L.) for winter crop in North-Eastern Indian condition

2. **Source of the technology:** CHF(CAU, Imphal), Pasighat, Arunachal Pradesh

3. **Year of adoption/ development:** 2014

4. **Description of technology with salient features:**

   The extent to which guava trees should be pruned and the most appropriate time for pruning of guava tree for winter crop has been studied by several workers, but there is a wide variation in the findings because the reports are of different climatic conditions. No report on time and severity of pruning of guava for winter cropping under North-Eastern Indian condition is available. Hence, Pruning Techniques for Harvesting of Winter Guava (*Psidium guajava* L.) cv. L- 49 was standardized for the North-Eastern Indian condition with the following objectives: To optimize the severity of shoot pruning in guava; to optimize the time of shoot pruning in guava; to eliminate rainy season crop and to obtain better quality fruit in winter season and to extend the harvesting season.

   Based on the observations made, pruning in mid-May is recommended as was found better for regulating cropping for winter season, good flowering, fruiting, fruit size and quality attributes.

   Similarly, 50% of the shoot length have very good responses on the yield and quality of fruits. On the basis of overall performance the study clearly revealed that pruning of 50% shoot length in mid-May (M_2P_2) was found to be the best among all the treatments for flowering, fruit set, fruit weight, yield and improvement of fruit quality of winter season guava in sub-tropical climate of foot hills of Arunachal Pradesh. Therefore, for crop regulation of guava in foot hills of Arunachal Pradesh, pruning of 50% of the shoot length in mid-May will be the ideal horticultural practice for obtaining good yield and quality fruits in winter season

5. **Critical inputs/items/tools required:**

   - Pruning tools, Skilled labour, plant protection chemicals, Manure and fertilizer

6. **Observation to be recorded:**

   - Plant Growth
   - Flowering
   - Fruit yield
   - Fruit Quality

7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs/ Farmers

8. **Precaution (s) with the technology:**

   Pruning time (Mid of May); Pruning intensity (50% of shoot length); Painting of cut ends of shoots/ branches with copperoxychloride; spray of copperoxychloride on foliage of plants during the rainy season to control canker.

Fig. 1 Shoot pruning in mid-May (50%)

Fig. 2 Shoot pruning in mid-May (50%)

Fig. 3 & 4 Fruitings after 50% pruning

9. **Advantage/ Benefits/ Utility of technology:**

   Availability of good quality guava fruits in winter season (November to January)

10. **Economics of the technology/ Benefit: Cost Ratio:**1 : 2.3

11. **Technology developed under the project:** PG research

12. **Investigator(s)/inventor(s):**

    Hau Ngaih Lian and Barun Singh: Email: barunchfcau@gmail.com; Mobile: 9436250944.

13. **Technology publication:**

    Hau Ngaih Lian, Barun Singh, Bidyarani Devi Senjam and Md. Ramjan (2019). Effect of Shoot Pruning on Growth and Yield of Guava (*Psidium guajava* L.) cv. L-49 under Foothills of Arunachal Pradesh. *Int.J.Curr.Microbiol.App.Sci.*, **8**(3): 2020-2027. DOI: https://doi.org/10.20546/ijcmas.2019.803.240. (NAAS RATING 2020: 5.38).

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TECHNOLOGY:
NECTAR-CM-13

1. **Name of the technology:** Wedge grafting in citrus
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Imphal**,** Manipur
3. **Year of adoption/ development:** 2015
4. **Description of technology with salient features:**

   Considerable success has been made to multiply citrus on the commercial scale by Wedge grafting. It is one of the simplest and easiest methods and largely used in the propagation of fruit. It is also used in top-working for changing varieties. In this method about 2-3 cm long two smooth slanting cutting are made at the proximal end of the 15 cm scion on both sides opposite to each other in such a way that the end portion becomes very thin. It is done with the help of sharp knife. The smooth long slanting cuts at the base of the scion gives an appearance of a sharp chisel. The rootstock of 15 cm length is at first beheaded by giving a cut and then a vertical split cut is made by a thin and sharp bladed grafting knife at the center of the cut surface of the stock having a depth of approximately 2-3 cm. Then, the scion is inserted into the wedge cut of rootstock through slight opening the splits. Thus, both components are brought into close contact particularly cambia in face to face and tied firmly with polythene strip. After wrapping the graft union, the scion along with the union portion is covered with a polythene cap to protect the scion from loss of moisture through transpiration. For NE region, the best time of grafting is Feb-March.

Selection of rootstocks	11- 12 months old seedling rootstocks with girth size 2.5 to 3.5 cm at 9" height from the ground level. The rootstock should be healthy and free from diseases.
Selection of scion mother plants for scion collection	Pest and disease free, healthy and uniform bearing 5-6 years old scion mother plants.
Selection and collection of scion materials	Non-flowering shoots of current season fresh growth having dark green coloured leaves, about 20 cm long, straight, smooth, healthy, pest and disease free and also of same thickness of rootstock

5. **Critical inputs required:** Rootstocks, scions**,** secateurs, sharp grafting knife, measuring scale, measuring tape, polythene cap, polythene strip and polybag.
6. **Observation to be recorded:**
   - Success percentage of the graft union
   - Time taken for healing of the graft union
   - Total Plant height
   - Root length and diameter
7. **Target users/stakeholders:** MTTc/ KVKs/Farmers
8. **Precaution (s) with the technology:** Selection of scion mother plant is an important factor for the propagation

of fruit plants by grafting. Quality scion mother plant with appropriate growing conditions assures higher percentage of graft success. The scion shoots should be of about 3-4 months old containing sufficient reserved food materials. The selected scion shoots should be detached from the mother plants with the help of sharp secateurs and defoliated leaving one-fourth of the petiole just after their detachment. The collected scion shoots should then be carried in a polybag with sphagnum moss and keep in shady cool place to avoid desiccation.

9. **Advantage/ Benefits/Utility of technology:** This is an easy method of Citrus propagation and can be adopted

Fig. 1 Preparation of the scion

Fig. 2 Cutting of the rootstock

Fig. 3 Insertion of the scion onto rootstock

Fig. 4 Wrapping the union

Fig. 5 Grafted plants covered with polythene sheet

Fig. 6 Healed plant

Fig. 7 The graft union

by small and marginal farmers to enhance the quality of fruits and yield in a short duration with less investment. Entrepreneurs can also benefit from this technique by selling the grafted seedlings.

10. **Economics of the technology/ Benefit:** 1.98

11. **Technology developed under the project:** Under PFDC, Imphal Centre, Horticultural Research Farm, Andro.

12. **Investigator(s)/inventor(s):**

    R. K. Dilip Singh and A. Thokchom**:** Email: rkdsingh59@gamil.com; Mobile: 9402882753.

13. **Technology publication:**

Thokchom, A. and Singh, R. K. Dilip (2018). Effects of grafting height and scion length on growth of *Citrus reticulata* var. Nagpur Mandarin. *Inter. J. Chem. Studies*, **6**(2): 2094-2097.

Thokchom, A., Singh, R. K. Dilip, Begane, N., Mathukmi, K. and Sebastian, K.S. (2019). Influence of grafting height and scion length on healing of graft union and growth characteristics of *Citrus reticulata* var. Nagpur Mandarin grafted on Rough lemon rootstocks. *Int. J. Curr. Microbiol. App. Sci.*, **8**(3): 2066-2074.

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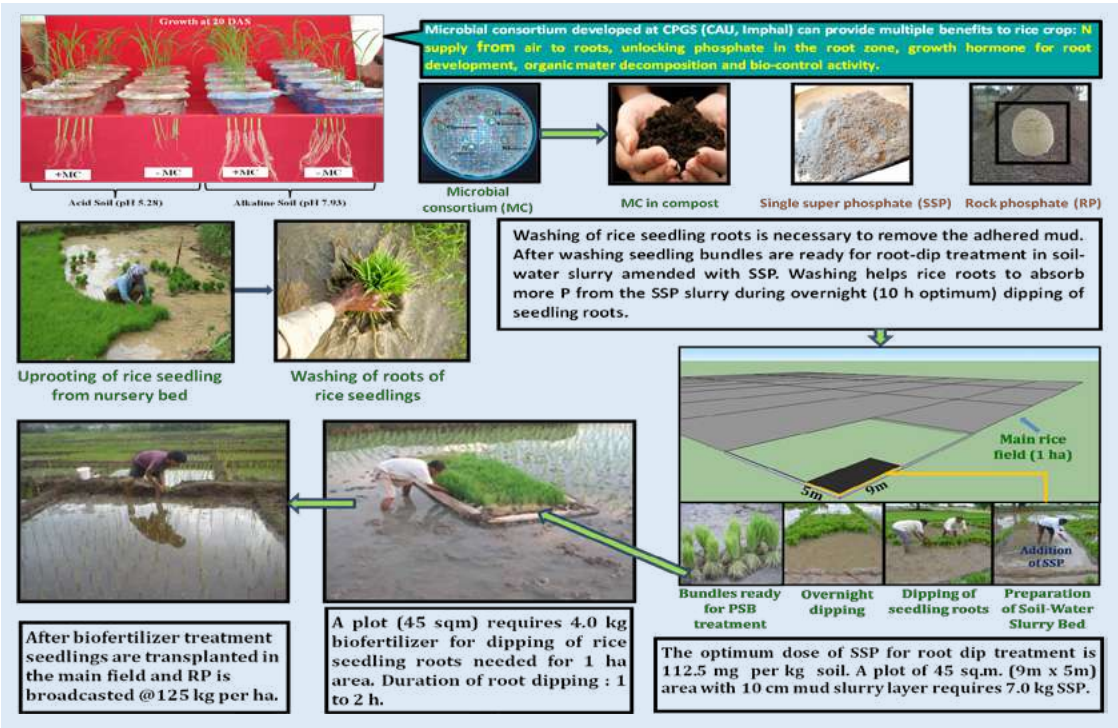
TECHNOLOGY:
NECTAR-CM-14

1. **Name of the Technology:** Root-dipping in SSP-MC slurry method of P management in rice-vegetable rotation
2. **Source of Technology:** CPGS-AS (CAU, Imphal), Umiam, Meghalaya
3. **Year of adoption/ development:** 2015
4. **Description of technology with salient features**:

   The deficiency of phosphorus (P) is widespread in acidic soils. The fixation of water-soluble P as $AlPO_4$ and $FePO_4$ causes P use efficiency as low as 15-20% of the applied quantity of water-soluble P fertilizer in a crop season. So, the application of higher quantity of inorganic P fertilizer is mere a wastage of poor farmers' money and can also pose a cause to environmental pollution. As an alternative to conventional P management in acid soil, the rhizosphere-based P management approach seems to be pertinent for enhancing P-use efficiency and yield of crops in acid soils.

   Strategies: (i) To increase tissue P content at the seedling stage for better root growth, (ii) to synchronize the rates of P mineralization in soil and P uptake in crops throughout the crop growing period and (iii) To minimize P fixation and mineralization of $AlPO_4$ and $FePO_4$ in the rhizosphere.



Methodological description:

Step-I: Root dipping in soil slurry amended with SSP:

Prepare a mud slurry bed (45 m^2) in one corner of the main field (area 1 ha) and follow the steps depicted in the figure. The amount of single super phosphate (SSP) requires for addition in the mud slurry bed is 8.0, 6.0 and 5.0 kg for Hybrid rice, HYV rice and traditional rice, respectively. This treatment is usually carried out in the evening hours and seedlings get ready for CAU-Bioenhancer treatment in the next morning. **CAU-Bioenhancer** is comprised of 5 efficient bacterial strains (*Arthrobacter* sp. **C4**; *Klebseilla* sp., **I3;** *Serratia marcescens*, **N3**; *Enterobacter* sp**.,** **P5** and *Pseudomonas putida,* **B1**) and these strains are compatible to each other and adaptable to acid soils**.** After completion of root-dipping in SSP-mud slurry, rice seedling bundles are to be taken out and kept aside on the bund. Apply approx. 5 kg finely grounded dry compost/FYM on the mud slurry bed along with CAU-Bioenhancer (4.0 kg for solid formulation or 500 ml liquid formulation) and mix thoroughly with mud. Then roots of rice seedling bundles are re-dipped in CAU-Bioenhancer treated mud slurry and incubated for 1 to 2 h. Now seedlings are ready for transplanting on the main field.

Prior to transplantation of the SSP-MC treated rice seedlings, apply rock phosphate in the main field @125 kg ha^{-1} along with 50% of the recommended dose of Urea (133 kg ha^{-1}) and MOP (66 kg ha^{-1}).

Salient findings:

Adoption of the root-dipping in SSP-MC Slurry Method of P Management along with 50% the recommended dose of fertilizers in farmers' fields could produce comparable or higher yields (up to 20-30% increase in rice and 25 to 50% increase in vegetables) of rice-vegetable rotation compared to that obtained under 100% recommended dose of fertilizers (farmers' recommended practice). Moreover, the quality parameters of vegetables (antioxidant activity and content of ascorbic acid, total phenol and β – carotene) was found to improve under SRD in SSP Soil slurry + 50% RDP + CAU-Jhum Bioenhancer application.

5. **Critical Input Required**: Rock phosphate, superphosphate, urea, MOP and liquid formulation of microbial consortium.

6. **Observation to be recorded**:

   - Root growth parameters at 40 or 45 DAT.
   - Number of effective tillers per hill and grains per panicle
   - Grain yield, biological yield and harvest index
   - N, P and K concentration in shoot at 45 DAT and Zn in edible portion of grain

7. **Target users/stakeholders:** MTTCs/ KVKs/Farmers of North East India, Govt. agencies, Agri-entrepreneurs, etc.

8. **Precaution (s) with the technology:**

   - This technology is suitable for transplanted rice and vegetable crops.
   - This technology demands biofertilizer that possesses the ability to dissolve insoluble phosphates and other micronutrient complexes.
   - The added amount of SSP shouldn't exceed the recommended quantity of SSP in mud slurry.
   - The duration of seedlings root dipping shouldn't exceed the recommended duration.

9. **Advantage/ Benefits/ Utility of technology:**

Suitable for application in acid soils, provided adaptive benefits against Al toxicity stress, suitable to apply in organic farming, and there is no crop specificity for CAU Bioenhancer.

10. **Economics of the technology/ Benefit: Cost Ratio:**

One half of the recommended dose of inorganic fertilizers (50% saving on expenditure) can be saved by adopting root-dipping in SSP+CAU Bioenhancer amended soil slurry method in transplanted crops grown in acid soil without compromising yield of rice and vegetables.

11. **Technology Developed under the project**:

DBT, GOI funded Research Project entitled "Endophyte diversity in wild versus cultivated rice across environmental gradients in North East India" (*vide* No. BT/PR15208/AGR/21/332/2011 dated 02- 07-2012).

12. **Investigator(s)/inventor(s):**

Dwipendra Thakuria: Email: thakuria.dwipendra@yahoo.co.in; Mobile: 9436767009

13. **Technology publication:**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India, Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter: 03, Technology No. 16: Root-dipping in SSP-MC Slurry Method of P Management: 109-111.

Kalidas-Singh, S. and Thakuria, D. (2018) Seedling root-dip in phosphorus and biofertilizer added soil slurry method of nutrient management for transplanted rice in acid soil. *Journal of Soil Science and Plant Nutrition,* **18**(4), 921-938. doi.org/10.4067/S0718-95162018005002701.

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TECHNOLOGY:
NECTAR-CM-15

1. **Name of the technology:** CAU-*JHUM* Bioenhancer (Liquid biofertilizer for mixed crops of *Jhum* fields)
2. **Source of the technology:** CPGS-AS (CAU, Imphal),Umiam, Meghalaya
3. **Year of adoption/ development:** 2016
4. **Description of technology with salient features:**

   CAU *JHUM* Bioenhancer is an ecofriendly liquid biofertilizer composed of four beneficial bacteria as consortium (*Pseudomonas fluorescens* CCF10T1; *Pantoea anthophila* TMF5T6; *Serratia marcescens* TMF5P7 and *Kosakonia radicincitans* BHF20T4). All four bacterial strains are compatible to each other and can grow together in growth medium. Jhum Bioenhancer can provided habitat-fitness benefits to *Jhum* crops, improves yield of mixed crops and it is non-specific to jhum crops.

   Rationale of the technology: Burning of slashed biomass of secondary forest stands on hill slopes for practicing *jhum* agriculture causes negative impact on functioning of microbiota and nutrient cycling in soils. The average productivity of *jhum* land is much below the average national productivity. The fertilizer use efficiency in soils of jhum fields is notoriously low due to runoff losses from hilly slopes. Moreover, resource poor *jhummias* can't afford input cost of inorganic fertilizers. So, the low-cost eco-friendly nutrient management practice is the need of hour for improving the productivity of *jhum* fields.

   Strategies: Bacterial colonizers of early succession plants from burnt *jhum* fields were isolated and screened for multifaceted plant growth promoting properties. These four efficient bacterial strains (CCF10T1, TMF5T6, TMF5P7 and BHF20T4) exhibited abiotic stress tolerance to heat (up to 65^0C), Al-toxicity (300 ppm) and soil acidity (up to pH 3.5) and higher abilities for dissolution of insoluble phosphates and Zn complexes, IAA-production, N_2-fixation, carbon mineralization and biocontrol activities in the crop rhizosphere.

   How does CAU-*Jhum* Bioenhancer work?: CAU-*JHUM* Bioenhancer promotes early root growth and crop establishment in acid soils. It can reduce soil acidity related stresses in crops and increase growth and yield of *jhum* crops by 20-40% when applied with rock phosphate @ 30 kg P_2O_5 ha^{-1} basis. Jhum Bioenhancer is suitable to all mixed *jhum* crops.

   Application guide:

   Seed treatment: Dilute 200 ml CAU JHUM BIOENHANCER with 400 ml clean water (1:2) and mix thoroughly with 500 g finely ground dry compost and 4 to 5 kg seeds. Keep it under shade for 1 hour and ready for sowing/dibbling in *jhum* field.

   Root-dip treatment: Prepare a mud plot (5-7 cm depth) of size 1 sqm (1 m x 1 m) in one corner of the main field. Apply 2 kg finely ground dry compost and 600 ml Bioenhancer to mud plot and mixed thoroughly. Dip rhizomes of ginger,

seedling roots of transplanted vegetables (18-24 h), seedling roots of transplanted rice of valleys (10 h), etc. Then seedlings are ready for transplantation. Care should be taken that seedling root should not get washed after treatment.

Foliar spray: Dilute 200 ml *Jhum* Bioenhancer in 10 litre clean water (1:5) and spray twice on crops. The 1st spray at the early growth stage and 2nd spray before flowering.

5. **Critical inputs required:**

Rock phosphate, liquid formulation of CAU Jhum Bioenhancer and well dried grounded compost/FYM (passed through 1 mm sieve or fine bamboo sieve).

Salient findings: The average increase in yield of*jhum* ricewas ranged from 21 to 30% in CAU-Jhum Bioenhancer + RP @30 kg ha^{-1} applied plots over the yield obtained (from 1.32 to 1.68 t ha^{-1}) in plots under traditional practice of *jhummias*.

6. **Observation to be recorded:**

- Root growth parameter at 40 or 45 DAT
- Number of effective tillers per hilland grains per panicle
- Grain yield, Biological yield and Harvest Index
- N, P, and K concentration in shoot at 45 DAT and Zn in edible portion of grain.

7. **Target users/stakeholders:** *Jhummias* of North East India and upland arable farmers, Govt. agencies, MTTCs, KVKs, Agri-entrepreneurs, etc.

8. **Precaution (s) with the technology:** The shelf-life of the liquid formulation is 100 days. The co-application of this biofertilizer alongwith other chemicals (herbicide/insecticide/inorganic fertilizers, etc.) should be avoided. For seed treatment, at least 7 days gap should be maintained between liquid biofetilizer treatment and neem oil/ or other botanicals treatment.

9. **Advantage/ Benefits/ Utility of technology:** Suitable for application in acid soils, provided adaptive benefits against Al toxicity stress, suitable to apply in organic farming, and this formulation is non-specific to crops.

10. **Economics of the technology/ Benefit: Cost Ratio:**

Investment of Rs. 500/- (cost of 1 l CAU-Jhum Bioenhancer needed for 1 acre/ or 4000 sq.m. area) can increase farmers' additional income by Rs. 3,000/- to Rs. 4,000/-.

11. **Technology developed under the project:**

NER-BPMC, DBT funded project entitled

"Assessment of *jhumming* on native plant and soil microbiota and restoration of sustainable jhum agroecosystems of NE India (DBT-NER/Agri/14/2012 dtd. 31/10/2012)".

12. Investigator(s)/inventor(s):

Dwipendra Thakuria; Email: thakuria.dwipendra@yahoo.co.in; Mobile: 9436767009/ 8787343877

13. Technology publication(s):

Thakuia, D. (2016). Performance evaluation of CAU Jhum microbial consortium in *jhummias* fields as Lengpuiviallge, Mizoram. *CAU Research Newsletter*, **1**(3): 3.

Thakuria D. (2017). A Consolidated Report on the Research Project "Impact Assessment of *Jhumming*on Native Plants and Soil Microbiota and Restoration of Sustainable *Jhum* Agro-ecosystem in North East India" submitted to the NER-BPMC, Department of Biotechnology, Ministry of Science and Technology, Govt. of India.

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TECHNOLOGY:
NECTAR-CM-16

1. **Name of the technology:** Influence of mulching on production potential and economic of rainfed rice-based cropping system
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Imphal, Manipur
3. **Year of development/adoption:** 2017
4. **Description of technology with salient features:**

- Surface mulching of paddy straw of 7.5 q ha^{-1} after harvest of paddy to the subsequent *rabi* crops like broad bean, field pea, lathyrus, wheat and oats would help in improving production efficiency of rice-based cropping sequence in acidic soils of Manipur.
- This technology would also help in conservation of residual soil moisture during the *rabi* season which increased yield of the *rabi* crops up to 20-30% and was more pronounced in oat and field pea.

5. **Critical inputs required:**

- Paddy straw 7.5 q ha^{-1} for mulching
- Paddy: 60 kg N: 40 kg P_2O_5: 30 kg K_2O ha^{-1}
- Broad bean/Fieldpea: 20 kg N: 60 kg P_2O_5: 30 kg K_2O ha^{-1}

6. **Observation to be recorded:**

- Grain/fodder and stover yield of each crop in the system
- Gross income, net income and Benefit Cost ratio
- Production efficiency (kg ha^{-1} d^{-1})
- Total production efficiency (Rs $ha^{-1}d^{-1}$)
- Duration of each crop in sequence
- Rice equivalent yield (REY)
- Land use efficiency (%)
- Soil moisture – to be recorded at 20 days interval from sowing

Fig. 1 Rice field

Fig. 2 Brad bean var. Local (a)With mulching(b) Without mulching

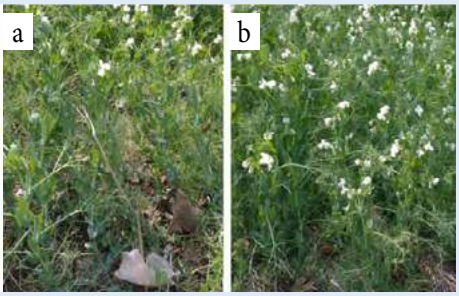

Fig. 3 Pea var. HUDP-15
(a) Without mulching (b) With mulching

7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs

8. **Precautions in technology:**

   The recommended technology for *kharif* and *rabi* crops to be followed. Surface mulching with paddy straw @ 7.5 q ha^{-1} to be done for *rabi* crops.

9. **Advantage of technology:**

   There was 59% increase in rice equivalent yield under rice broad bean sequence over sole rice cropping.

10. **Economics of the technology/ Benefit: Cost Ratio:**

    Among the cropping sequence rice- broad bean was found to be most remunerative with higher gross income (Rs. 1,98,390 ha^{-1}), net income (Rs. 1,64,944 ha^{-1}) with a benefit cost ratio (5.94) followed by rice – pea with mulching under rainfed condition of Manipur.

11. **Technology developed under the project:**

    University Project: IRP Code-Agri. IRP-IV/2013-14: Influence of mulching on production potential and economic of rainfed rice-based cropping in Manipur.

12. **Investigator(s)/inventor(s):**

    Edwin Luikham, K. S. Shashidhar: Email: edluikham@rediffmail.com; Mobile: 9612166954.

13. **Technology publication:** Yet to be published.

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TECHNOLOGY:
NECTAR-CM-17

1. **Name of the Technology:** Biofortified Enriched Compost (BEC) for enhanced pulse production in acid soil
2. **Source of Technology:** CPGS-AS (CAU, Imphal), Umiam, Meghalaya
3. **Year of adoption/ development:** 2018
4. **Description of technology with salient features**:

Rationale of the technology:

There is tremendous scope for increase in the acreage of pulse crops especially lentil and peas in the North Eastern Region of India. But the productivity of lentil and pea crops in NE India is mainly constrained by soil acidity and relatively lower population of effective *Rhizobia* in acid soils. In order to increase the acreage and productivity of lentil and peas in acidic soils under rice fallow, there is an urgent need for development of an efficient nutrient management practice.

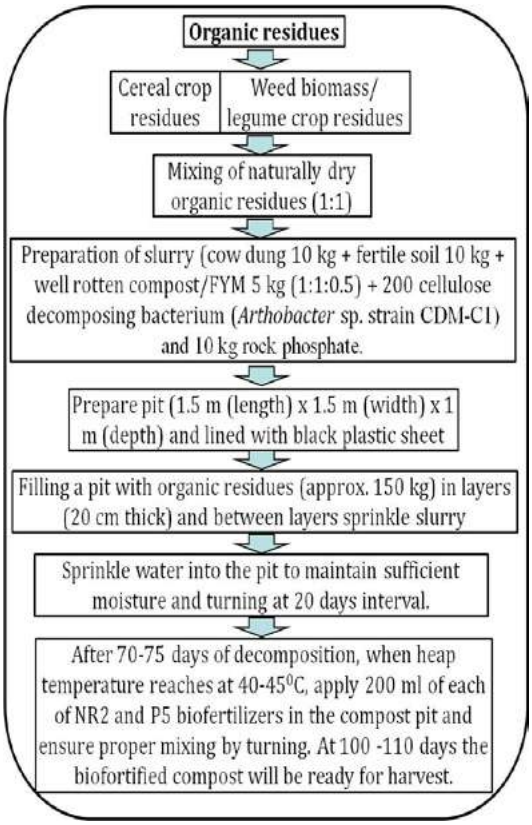
Strategies:

Treatment of lentil and pea seeds with host-specific *Rhizobium* is a common practice for enhancing N_2-fixation and thereby yield enhancement. However, the *Rhizobium*-legume symbiosis often fails to deliver the desired yield benefits in acidic soils. The main reasons are: (1) P and Mo deficient acid soil, (2) poor nodulation due to ineffective *Rhizobium*, (3) poor colonization by *Rhizobium* on seed surface due to desiccation effect, (4) Al-toxicity in the crop rhizosphere under upland situation, and (5) poor rhizopshere competence. In order to address the above challenges, this technology will ensure the production of P enriched compost biofortified with *Rhizobium* and phosphate solubilising bacterium (PSB). The aim of biofortification of compost with *Rhizobium* is to ensure colonization not only through seed treatment but also the rhizosphere zone through line application at the time of sowing. Further, spiking of this compost with an efficient PSB strain will ensure P mineralization in the rhizosphere zone for early P nutrition to the seedling in acid soil condition.

Methodological description:

The flowchart depicts the procedure for making BEC compost using an efficient cellulose decomposing bacterium, *Arthrobacter* sp. (strain CDM-C1) in order to hasten the composting process and enriched the compost with rock phosphate for higher P concentration. Towards the later stages of the composting process, when heap temperature reaches around 40-45^{0}C, biofortification is done with *Rhizobium* and PSB bioinoculants. An acid soil compatible *Rhizobium* strain *Rhizobium leguminosarum* bv. viceae (NR2) belonging to pea cross-inoculation group and an efficient phosphate solubilising bacterium, *Enterobacter* sp. (strain P5) are recommended for biofortification of the compost.

At maturity, the BEC compost contains 2.3% N, 1.7% P and 1.3% K. The population of CDM-C1, NR2 and P5 per g compost at the maturity ranges from 1.2 to 6.2 to $\times 10^8$ cfu, 1.6 to 2.5 x 10^8 cfu and 7.0 to 9.3 $\times 10^8$ cfu, respectively. The ash alkalinity of the BEC compost ranges from 38.3 to 54.7 k mol H+ kg^{-1} $X10^{-5}$. The C:N ratio of the BEC compost ranges from 12:1 to 15:1. The pH of the BEC compost ranges from 7.4 to 7.6 and EC ranges from 2.2 to 2.5 dS m^{-1}.



Salient findings:

The application of BEC compost as seed treatment and line application @ 2.5 t ha^{-1} in line at the time of seed sowing along with 50% of the recommended dose of NPK fertilizers (50% RDF) increased yield of lentil crop to the tune of 30 to 60% over that (0.90 to 1.1 t ha^{-1}) obtained under 100% RDF. The application of BEC compost enhanced nodulation efficiency in lentil crop by 70 to 120% over that in no BEC compost applied plot.

5. **Critical inputs required**: Crop residues, weed biomass, rock phosphate, *Rhizobium leguminosarum* bv. viceae (NR2), *Enterobacter* sp. (strain P5), Cellulose degrading bacterium (strain CDM-C1)

6. **Observation to be recorded**:

   - Nodule numbers and weight per plant at 50 to 60 DAS and root weight
   - Number of branches per plant
   - Pod and seed yield, biological yield and harvest index
   - N, P and K concentration in shoot at 50 to 60 DAS

7. **Target users/stakeholders:** Farmers of North East India, Govt. agencies, MTTCs, KVKs, Agri-entrepreneurs.

8. **Precaution (s) with the technology:**

   - Biofortification should not be done before 60 days of decomposition
   - *Rhizobium*, PSB and CDB strains must be compatible to each other
   - *Rhizobium*, PSB and CDB strains are preferably native and adaptable to acid soil condition.
   - If BEC compost is to be applied in other legume crops, *Rhizobium* strain must be legume host-specific and compatible to PSB and CDB strains.

9. **Advantage/ Benefits/ Utility of technology:**

   Suitable for application in acid soils, provided adaptive benefits against soil acidity, suitable to apply in organic farming.

10. **Economics of the technology/ Benefit: Cost Ratio:**

    The half of the input cost on inorganic fertilizers can be saved. Application of BEC compost in lentil cultivation can give an additional income of Rs.16000/- to Rs. 20000 ha^{-1}.

11. **Technology developed under the project**:

    This technology was developed under the College Research Programme of CPGS-AS, Umiam with financial assistance from the CAU (Imphal), Manipur.

12. Investigator(s)/inventor(s):

Dwipendra Thakuria: Email: thakuria.dwipendra@yahoo.co.in; Mobile: 9436767009

13. Technology publication(s):

Sangma, C. B. K. and Thakuria, D. (2019). Isolation and Screening of Cellulose Degrading Microorganisms from Forest Floor Litters of *Jhum* Fallows. *Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci.*, **89**(3): 999–1006. https://doi.org/10.1007/s40011-018-1015-8.

Sangma, C. B. K. and Thakuria, D. (2018). Evaluation of native *Rhizobium leguminosarum* bv. viceae of pea plants (*Pisum sativum* L.) for nodulation efficiency and yield promotion in lentil crop (*Lens culnaris* Medik.) under acid soil. *Legume Research,* LR-4001: 1-6. DOI: 10.18805/LR-4001.

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TECHNOLOGY:
NECTAR-CM-18

1. **Name of the technology:** Phosphorus recommendation for promising varieties of lentil
2. **Source of the technology:** COA(CAU, Imphal), Iroisemba,Manipur
3. **Year of adoption/ development:** 2018
4. **Description of technology with salient feature:**
   - The experiment was laid out in factorial randomized block design with 3 replications. The treatment consisted of four levels of phosphorus (0, 20, 40 and 60 kg P_2O_5 ha^{-1}) and three varieties (PL 4, HUL 57 and DPL 62).
   - Application of 40 kg P_2O_5 ha^{-1} through SSP to lentil varieties HUL 57 and DPL 62 for enhancing the productivity and quality.
   - Crude protein content (23.91%) in seed and crude protein yield (264.81q ha^{-1}) increased with the application of 40 kg P_2O_5 ha^{-1} compared to control (22.50%; 170.07 q ha^{-1}).
   - Among the varieties, the variety HUL 57 recorded highest net income (Rs 37,639 ha^{-1}) and benefit cost ratio (2.05). The highest benefit cost ratio was associated with 40 kg P_2O_5 ha^{-1} (2.11).
5. **Critical inputs required:** 20:40:20 kg NPK ha^{-1}
6. **Observation to be recorded:** Growth parameters, yield parameters and grain yield
7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs

Fig: 1 HUL 57 variety with 40 kg P_2O_5 ha^{-1} at vegetative and maturity stage

8. **Precaution (s) with the technology:** Strictly follow the recombination/ technology

9. **Advantage/ Benefits/ Utility of technology:**

   There was an increase of 46% in seed yield with the application of 40 kg P_2O_5 ha^{-1} over control. The variety HUL 57 showed about 11% increase over PL 4.

10. **Economics of the technology/ Benefit: Cost Ratio:**

    Highest Benefit cost ratio (1:2.05), gross income (Rs. 73150 ha^{-1}) and net income (Rs.37639 ha^{-1}) was recorded in the variety HUL 57 with the application of 40 kg $P_2O_5ha^{-1}$(2.11).

11. **Technology developed under the project:**

    Influence of phosphorus on yield of promising varieties of lentilfunded by CAU, Imphal.

12. **Investigator(s)/inventor(s):**

    Edwin Luikhamand, Tophia Yumnam: Email:edluikham@rediffmail.com; Mobile 9612166954.

13. **Technology publication(s):**

    Tophia Yumnam, Edwin Luikham and A. Herojit Singh. (2018). Influence of Phosphorus on Growth and Yield of Promising Varieties of Lentil (*Lens culinaris* L. Medik). *Int. J. Curr. Microbiol. App. Sci.,* **7**(8): 162 – 170. (DOI: https://doi.org/10.20546/ijcmas.2018.708.021). NAAS rating 2020: 5.38.

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TECHNOLOGY:
NECTAR-CM-19

1. **Name of the technology:** Zinc fertilizer for better growth and yield of tomato
2. **Source of the technology:** COA (CAU, Imphal), Irosimeba, Manipur
3. **Year of adoption/ development:** 2018
4. **Description of technology with salient features:**

Tomato is one of the major vegetable crops predominantly grown in the valley areas of Manipur both under irrigated and rainfed condition. Tomato fruits are very popular because of their high nutritive value and diversified uses. Its nutritive value is very high because of higher contents of A, B, C vitamins and calcium. Zinc (Zn) is an important plant micronutrient which helps in the formation of tryptophan, a precursor of IAA responsible for growth stimulation and plays a vital role in synthesis of carbonic anhydrase enzyme which helps in transport of CO_2in photosynthesis. Soil contains zinc in the range 5–770 ppm with an average of 64 ppm. Application of zinc @ 10 kg ha^{-1} in the form of zinc sulphate is recommended for obtaining satisfactory yield of tomato and for improving the quality of fruits and zinc content in the fruits.

Table 1 Effect of different levels of Zn application on yield of Tomato (t ha^{-1})

Sl. No.	Treatment	2016-17	2017-18	Average yield (t ha^{-1})
T_1	Control	26.39	42.18	34.29
T_2	Zn @ 2.5 kg ha^{-1}	43.78	47.94	45.86
T_3	Zn @ 5.0 kg ha^{-1}	45.63	50.79	48.21
T_4	Zn @ 10.0 kg ha^{-1}	50.69	51.54	51.12
CD(p=0.05)				1.99

Control

Treatment

20 DAT

Control

Treatment

40 DAT

Control

Treatment

60 DAT

Control

Treatment

Fig. Effect of Zn fertilizer on Tomato yield

Critical inputs required: N: P: K:: 60 : 35: 35 kg ha^{-1}. along with zinc @ 10 kg ha^{-1} in the form of zinc sulphate.

5. **Observation to be recorded:** Growth parameters, yield parameters and fruit yield

6. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs/Farmers

7. **Precaution (s) with the technology:** Proper irrigation should be maintained. Protection measures against diseases to be taken up as it is prone to fungal blight.

8. **Advantage of technology/variety:** The best treatment (zinc @ 10 kg ha^{-1}) gave 49% higher yield over the treatment without zinc application (control)

9. **Economics of the technology/ Benefit: Cost Ratio:** 1: 3.

10. **Technology developed under the project:** Effect of zinc on growth and yield of tomato (*Lycopersicon esculentum cv.* pusa ruby).

11. **Investigator(s)/inventor(s):**Indira Sarangthem and Dasari Gopal: Email: indira_sarangthem@yahoo.co.in; Mobile: 8731931772

12. **Technology publication(s):**

Gopal, D. and Sarangthem, I. (2018). Effect of zinc on growth and yield of tomato (*Lycopersicon esculentum* CV. Pusa Ruby). *Int. J. of Current Res.*, **10**(9): 73616-73620.

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TECHNOLOGY:
NECTAR-CM-20

1. **Name of the technology:** Optimum sowing time and integrated nutrient management for enhancing the yield of local glutinous maize
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Manipur
3. **Year of adoption/ development:** 2019
4. **Description of technology with salient features:**
   - Best sowing time for glutinous maize in Manipur is 20th March to 9th April. Apply 75% recommended nitrogen through urea and 25% nitrogen through farm yard manure gives for getting highest yield in glutinous maize.
   - Highest grain yield was recorded when crop sown on 9th April (27.49 q ha^{-1}) with 75% recommended nitrogen through urea and 25% nitrogen through farm yard manure (32.90 q ha^{-1}).
5. **Critical inputs required:** 60:30:20 :: N : P : K kg ha^{-1}
6. **Observation to be recorded:** Growth parameters, yield parameters and grain yield
7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs
8. **Precaution (s) with the technology:** Strictly follow the recombination/ technology
9. **Advantage/ Benefits/ Utility of technology:**

   The integration of 75% inorganic and 25% through organic source of Nitrogen could increase the grain yield of glutinous maize by about 33% over that of 100% only through organic source.
10. **Economics of the technology/ Benefit: Cost Ratio:**

    Highest gross income (Rs 2,39,757 ha^{-1}), net return (Rs 1,91,578 ha^{-1}) and BC ratio (3.98) were associated with the crops sown on 9th April sowing with the application of 75% recommended nitrogen through urea and 25% nitrogen through farm yard manure.

Fig. 1 Local glutinous maize in the field

Fig. 2 Harvested local glutinous maize

11. **Technology developed under the project:**

Influence of sowing time and integrated nitrogen management on growth and yield of local glutinous maize

12. **Investigator(s)/inventor(s):**

Edwin Luikham and Tabuiliu Abonmai: Email:edluikham@rediffmail.com; Mobile: 9612166954

13. **Technology publication(s):**

Tabuiliu Abonmai, Edwin Luikham, Kazamba Kamwenu and Kumar Sambhav Giri (2019). Influence of Sowing Time and Integrated Nitrogen Management on Growth and Yield of Local Glutinous Maize (*Zea mays* L.). *Int. J. Curr. Microbiol. App. Sci.,* **8**(6): 2512-2518; (DOI: https://doi.org/10.20546/ijcmas. 2019.806.301). NAAS rating 2020: 5.38.

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TECHNOLOGY:
NECTAR-CM-21

1. **Name of the technology:** Scientific cultivation of arrowhead (*Sagittaria sagittifolia*), an unexplored marshy-land crop

2. **Source of the technology:** COA (CAU, Imphal), Iriosemba, Imphal, Manipur

3. **Year of adoption/ development:** 2019

4. **Description of technology with salient feature:**

Arrowhead (*Sagittaria sagittifolia*) is an attractive semi-aquatic plant with arrow shaped leaves and edible tubers belonging to the family Alismataceae and genus, *Sagittaria*. The plant is popularly known as *Koukha* in Manipur. *Koukha* is an unexplored herbaceous, perennial plant, propagated through seeds, tubers or pieces of stolones. It grows wild in marshy lands with 10 to 50 cm standing water or on a limited extent cultivated as mixed crop with low land rice. But it can as well be well cultivated as a sole crop.

- **Seedling**: Seedlings can be raised in a corner of the field during May - June. The seedlings are ready for transplanting at 3 to 5 leaved stage(20-25 days)
- **Transplanting time**: June-July is favourable but can be extended up to August depending upon the suitability of water level of the field.
- **Spacing:** 20 cm x 10 cm is the best for sole or one row in between two rows of rice at 10 cm intraspacing.
- **Weeding:** Two hand weedings at 20th & 45th days after transplanting should be done.
- **Manuring**: With little dose of fertilizer @ 40:30:30 kg NPK ha^{-1} the plant grows luxuriantly even under marginal lands. No need of extra fertilizer in intercropping.
- **Plant protection**: No noticeable pest and diseases are observed except leaf roller. It can be controlled easily by spraying endosulfan @ 3 ml l^{-1} of water.
- **Water management**: If water level in the field is controllable, a water depth of 30 cm. can be best maintained during peak vegetative growth period.
- **Harvesting**: Usually the crop is ready in 130 to 150 days for harvesting. After drying of leaves, the tubers have to be dug out but can the harvest can be postponed, depending upon the convenience of the farmer and land situation up to February/ March.

It is observed that the lowest net return was recorded from sole rice cropping and the highest in sole arrowhead cropping. Among the intercrops, the highest total rice equivalent yield (135.22 qha^{-1}), net return (Rs.2,48,050 ha^{-1}) and netreturn per rupee investment (Rs. 2.76) was observed in rice arrowhead intercropping in 1:1 row ratio combination in replacement series, followed by 3:2 row ratio combination in replacement series. The system can increase the net return of Rs 56,250 ha^{-1} from sole crop rice to the tool of Rs. 2,48,050 ha^{-1} in 1:1 row ratio rice + arrowhead intercropping in replacement series.

5. **Critical inputs required:**

- Planting materials (seeds/seedlings) and fertilizers

6. **Observation to be recorded:**

- For multi-locational testing observations on yield attributes like number of tubers/

Fig. 1 Sole arrowhead cultivation

Fig. 2 Arrowhead inter-cropping with rice

Fig. 3 Harvested Arrowhead tubers

plants, tuber size and weight, number of plants per sq. meter can be recorded.

7. **Target users/stakeholders:** Farmers

8. **Precaution (s) with the technology:** In intercropping arrowhead should be transplanted after 10 days of transplanting rice. No post emergence herbicides are allowed. In intercropping arrowhead should be harvested after rice harvest.

9. **Advantage/ Benefits/ Utility of technology:** Higher remuneration can be earned by the lowland rice farmers through this technology. Many wasteland s can be utilized for earning.

10. **Economics of the technology/ Benefit: Cost Ratio:**

- The present market price of arrowhead tuber is Rs. 100 to 120 kg^{-1}.
- If properly cultivated, it can yield 4 to 6 tha^{-1} which can earn a gross return of Rs. 4 to 7.2 lakhs ha^{-1}
- Cost of production is hardly Rs. 60 to 85 thousand ha^{-1}
- An approximate net return of 1.11 to 5.53 lakhs ha^{-1} can be earned through arrowhead cultivation
- Benefit cost ratio upto 6.5 can be earned through sole cropping

11. **Technology developed under the project:** Intramural project (University Project)

12. **Investigator(s)/inventor(s):** L. Nabachandra Singh; Email: nabachandra61@gmail.com; Mobile: 9436026544

13. **Technology publication(s):**

Singh, L. Nabachandra (2013). Reclamation of marshlands by using underutilized crop arrowhead (*Sagittarius sagittifolia*). pp. 64-72. *In*: Developing the potential of underutilized horticultural crops of hill regions, N. Prakash, S. S. Roy, P. K. Sharma, S. V. Ngachan (eds.). Pub: Today and Tomorrow Printers and Publishers, Jaipur, India.(ISBN-10: 8170194733; ISBN-13: 978-8170194736).

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Chapter - 3

CROP PROTECTION (CP) 16 technologies

TECHNOLOGY:
NECTAR-CP-22

1. **Name of the technology**: Indigenous glue trap - an effective non-lethal tool for rodent management
2. **Source of technology**: COA (CAU, Imphal), Iroisemba, Manipur
3. **Year of adoption/development**: 1998
4. **Description of technology with salient features**:

For many years anticoagulant rodenticides have been used to control rats, in spite of the proven risk of secondary poisoning of non-target predators and scavengers. The investigators developed a glue from locally available materials for trapping rats around home or business places.

Different combinations of locally available latex and resins were prepared and evaluated against rat for developing effective glue for rodent trapping. Finally, a rodent trapping glue has been developed from the latex of *Ficus religiosa* and resin of *Pinus khasia*. The glue can be prepared by dissolving 50 g of powdered resin of *P. khasia* in 100 ml of hot (100±10°C) oil of *Sesamum indicum* to which 1000 ml latex of *F. religiosa* should be added. The mixture should be boiled with occasional stirring for 10 minutes till it becomes glutinized and then the product can be used after cooling at room temperature by coating on a piece of card board. The glue can be stored under room temperature for many weeks in a dust proof container and can be used again and again by heating it with 10-15 ml of sesame oil kg^{-1} of glue.

The glue has been found to be very effective in trapping house rats with 90%, 80%, 60%, 50% and 40% trapped animals at 1, 2, 3, 4 and 5 days after treatment, respectively.

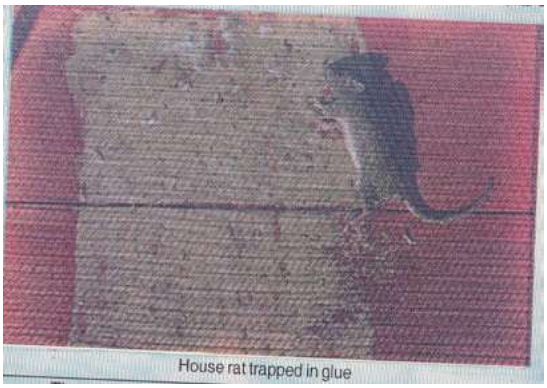

Fig. 1 & 2 Hose rat trapped in glue

5. **Critical inputs required**: Latex of *Ficus religiosa*, Resin of *Pinus khasia*, sesame oil and card board
6. **Observation to be recorded**: No. of trapped animals up to 5 days of treatment
7. **Target users/stakeholders**: Multi-Technology Testing Centres (MTTCs)/ KVKs/Farmers/ Housewives
8. **Precaution(s) with the technology**: The glue should be stored in dust proof container

9. **Advantage/Benefits/Utility of the technology**:

   The glue can be easily prepared from locally available materials and easy to use, cheap, ecologically safe and can cater the need of marginal farmers, who are handicapped for want of resources. The glue is also effective against bird pests, wall lizards and houseflies.

10. **Economics of the technology/Benefit:** 1: 2.9

11. **Technology developed under the project**: "Management of rodent pests with glue trapping" funded by ICAR, New Delhi

12. **Investigator(s)/ Inventor(s)**: M. Premjit Singh and K. I. Singh: Email: mpremjit55@gmail.com.

13. **Technology publication(s)**:

Singh, M. P. and Singh, K. I. (1998). Glue Trap - an effective non-lethal tool for rodent management. *CAU Newsletter*, IV(3&4): 2.

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TECHNOLOGY:
NECTAR-CP-23

1. **Name of the Technology:** Technology for Storage of planting material for effective management of rhizome rot of ginger
2. **Source of technology:** CHF (CAU, Imphal), Pasighat, Arunachal Pradesh
3. **Year of adoption/development:** 2009
4. **Description of technology with salient feature:**

The farmers normally store the ginger planting materials in the bamboo basket, open place and gunny sack cloth that leads to drying and rotting of ginger planting material. In this technology, the standardised methodology is provided to store the ginger planting material for 3 to 4 months.

- Choose an elevated place for storing the ginger planting material.
- Make a pit of 1 x 2 m^2 size under the shade.
- Shade should be made of polythene or local palm leaves.
- Spread a 5 cm uniform layer of sand at the bottom of pit.
- Mix 5 g CAU Green Gold (*Trichoderma* Bio-control Agent) in 1 l of water then immerse one quintal of ginger planting materials for 30 min.
- Treated rhizomes should be kept in shade for 24 h.
- The treated and dried rhizomes should then be kept in the pit and cover with fine sand.
- The ginger planting materials can be stored up to 3 to 4 months.
- These stored rhizomes will be free from disease and with good vigour and ready to plant without any seed treatment (**Table 1**).

Table 1 Disease incidence (%) and sprouting (%) in different methods of storing of ginger planting material

Method of storage of ginger	Open bamboo basket	Gunny sack cloth	Mancozeb treated and placed in pits	*Trichoderma* treated & placed in pits (Depth 2-3 feet)
Diseased ginger	15-18	26-30	2-3	0
Dried	60-65	5-10	0	0
Sprouted (%)	6-7	25-28	70-75	70-72

5. **Critical input required:**

- *Trichoderma* bioformulation
- Ginger planting materials
- Sand
- Polythene shade

6. **Observation to be recorded:**

- Viability of ginger
- Diseased ginger
- Germination percentage

Fig. (a-d) Stepwise procedure to store the ginger planting material
a. Planting materials **b.** Pit size (1 x 2 m^2) **c.** Rhizome treatment **d.** Covering with fine sand

7. **Target users/stakeholders:** Farmers

8. **Precaution(s) with the technology:**

- Prepare the pit in the higher elevation
- Avoid the water seepage to the pit

9. **Advantage/ Benefits/ Utility of technology:** Ginger planting material can be stored for up to 6 months.

10. **Economics of the technology/ Benefit: Cost Ratio:** Total cost of establishing pit is 2500.

11. **Technology developed under the project:**

    DBT, GOI funded project entitled "Exploitation of native *Trichoderma* spp. for management of rhizome rot of ginger in Arunachal Pradesh"

12. **Investigator(s)/ inventor(s):** P. Raja and B. N. Hazarika: Email: prajachf@gmail.com; Mobile 9436447356.

13. **Technology publication:**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter-2: Technology No. 14: Storage of Planting Material for Effective Management of Rhizome Rot of Ginger: 148-149.

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TECHNOLOGY:
NECTAR-CP-24

1. **Name of the Technology:** Mass production of *Trichoderma viride* a biocontrol agent

2. **Source of technology:** CHF (CAU, Imphal), Pasighat, Arunachal Pradesh

3. **Year of adoption/ development:** 2010

4. **Description of technology with salient features:**

Soil borne pathogens *viz.*, *Fusarium*, *Verticillium*, *Pythium* are major problems in vegetables, tree bean etc. The bio-control agent *Trichoderma* sp. was isolated from Arunachal Pradesh tested for their efficacy against soil borne pathogens under *in vitro* and *in vivo* conditions. Isolated *Trichoderma viride* was mass multiplied in the laboratory further study and the bioproduct was named as CAU GREEN GOLD. Molasses yeast medium is prepared in culture flasks and sterilized at 1.1 kg cm^{-2} for 20 minutes. *Trichoderma* culture is inoculated by taking a fungal disc from 10-day-old culture and incubated for 10 days. The fungal biomass and broth are mixed with talc powder at 1: 2 ratio. The mixture is air dried and mixed with Carboxy Methyl Cellulose (CMC) @ 5 g kg^{-1} of the product. It is packed in Polythene covers. Fresh product should contain not less than 9 x 10^9 cfu g^{-1}

Procedure:

- Prepare potato dextrose broth media (Potato 200 g, Dextrose 20 g, Distilled water 1000 ml) in culture flasks and sterilize at 1.1 kg cm^{-2} for 20 min.
- Inoculate 10-day-old *Trichoderma viride* culture into conical flasks and incubate it at 22^0C for 10 days.
- Mix well grown fungal biomass with talk powder at the ratio of 1: 1.
- Air dry the mixture and mix it with carboxymethyl cellulose @ 5 g kg^{-1} of product.
- Count the fungal population and pack in polythene bag.
- The fresh product should contain not less than 10^9 cfu g^{-1}.

Recommendation:

- Seed treatment with BCA 2 g l^{-1} water for 30 minutes + Soil application of BCA (5%) is effective.

5. **Critical Inputs required:**

- Mass Multiplication of *Trichoderma viride*
- Molasses yeast medium:

  - Molasses : 30 g

  - Yeast : 5 g
- Distilled water : 1000 ml

6. **Observation to be recorded**

- Quality of the medium
- Microbial population in the end product
- Viability of the biocontrol agent

7. **Target users/stakeholders:** MTTCs/ KVKs/Farmers

8. **Precaution(s) with the technology:**

- Set the incubation temperature
- Wear mask while preparing the mixture

9. **Advantage/Benefits/Utility of technology:** The bio-product CAU

GREEN GOLD is better than other *Trichoderma* production in NEH region

10. **Economics of the technology/ Benefit:** BC ratio is 1: 2.2

11. **Technology developed under the project:**

    DBT, GOI funded project entitled "Exploitation of native *Trichoderma* spp. for management of rhizome rot of ginger in Arunachal Pradesh"

12. **Investigator(s)/inventor(s):** P. Raja and B. N. Hazarika: Email: prajachf@gmail.com; Mobile 9436447356.

13. **Technology publication:**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter- 4: Technology No. 12: Mass production of *Trichoderma viride* a biocontrol agent: 144-146.

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TECHNOLOGY:
NECTAR-CP-25

1. **Name of the technology:** Mushroom cultivation technology for Arunachal Pradesh
2. **Source of the technology:** CHF (CAU, Imphal), Pasighat**,** Arunachal Pradesh
3. **Year of adoption/development:** 2011
4. **Description of technology with salient features:**

Mushroom house: It can be constructed with bamboo frames. Air vents on the upper walls and side walls should be provided for ventilation. The walls may be covered with gunny cloth to increase the relative humidity to 80-85% in the production house. The sides are covered with *tokko patta* (palm) plants. The floor of the shed is filled with sand to a uniform height of 10 cm. The house should have different rooms as described below.

Fig. 1 Mushroom House made from local materials

Spawn running room: Spawn running room is where the beds are kept for running of spawn under dark ventilated conditions. Temperature in the spawn running room should be maintained between 25-28^{0}C.

Fig. 2 Mushroom spawn production process

Fig. 3 Different stages of mushroom production process

Cropping room: Cropping room is the one where the opened mushroom beds are to be kept after completion of spawn running. Fruiting requires a temperature range of 20-28^{0}C, cross ventilation (2-3 h daily by opening doors and window) and light (2-4 h 24 h^{-1} from fluorescent tube), moisture and humidity range of 80-95%.

Substrate for mushroom cultivation: *Pleurotus* spp. can be grown on the tropical wastes like rice straw, wheat straw, corn cobs, dried water hyacinth, sugarcane bagasse, banana leaves, cotton waste or sawdust. Paddy straw is cheap, easily available and used as a substrate in Pasighat. Hand thrashed and fresh paddy straw cut into 3 to 5 cm length were used for pasteurization.

Pasteurization of substrate (Hot water treatment): Soak the chopped 3-5 cm paddy straw in cold water for 4 hr in a drum (Plastic/ Tin/ Iron). Drain out the water and add fresh water and cover the drum with gunny sack. Boil the contents over a flame for 45-60 minutes. After boiling, take out the straw and drain the excess water by keeping in wire baskets. Spread the straw as thin layer on a hessian cloth, spread on a raised platform. Shade dries the straw to obtain 60-65% moisture capacity.

Precautions to be observed: The straw should not be dried on the floor. The hessian cloth should be disinfected with it is a commercial product. Donot use this wordor any disinfectant before use. The 60 % moisture content in the straw can be judged by taking a handful of straw and squeeze it tightly.

Fig. 4 Different stages of mushroom production process

Preparation of mushroom bed: For preparation of bed (spawning) use 60 x 30 cm polythene bags of 80 gauge. Wash hands thoroughly with antiseptic lotion or Dettol liquid/soap. Take the polythene cover and tie the bottom end with a thread and turn it inwards, make two holes of 1 cm dia in the middle to ensure aeration. Mix the dried straw thoroughly to get a uniform moisture level in all areas, put the processed straw in the bottom of the bag to a height of 7.5 cm, sprinkle 25 g of spawn. Fill the second layer of straw to a

height of 12.5 cm and spawn it as above. Repeat the process to get four layers of spawn and 5 layers of straw. The last layer of straw to be of 5 cm height. Tie the mouth with twine (rubber band). Arrange the beds inside the thatched shed, (Spawn running room) following rack system or hanging system. Maintain the temperature of 22-25^{0}C and relative humidity of 85-90 % inside the shed. Observe the beds daily for contamination, if any. The contaminated beds should be removed and destroyed after 15-20 days of spawn running period, cut and remove the polythene bag and transfer the beds to cropping room. Maintain cropping conditions. Keep the beds moist by periodical spraying with water.

Precautions to be observed: Keep the spawn running room dark so that spawn running will be faster. Periodically place Rat-baiting to kill rats as they are attracted by the spawn. Periodically sprinkle water on sand layer to maintain the required conditions. Never spray any insecticides on the mushroom beds.

Harvest and yield: Mushroom pin heads appear on 3rd or 4th day of opening of beds. Matured mushrooms can be seen 3-4 days after pin head formation. Harvest matured mushrooms before spraying water. To harvest the mushrooms, they are held by the stalk and gently twisted and pulled. A knife should not be used. The mushrooms remain fresh for up to 3-6 days in a refrigerator/cool place. Second and third harvest can be obtained after scraping the surface of beds to 1-2 cm deep after first or second harvest. The entire cropping will be over in 40- 45 days.

Storage and packaging:

- At ambient temperature mushroom can be stored for up to 48 hours and in cold storage conditions up to 4-7 days.
- After harvesting wash in running tap water and immediately store at 5^{0}C.
- Packaging of mushroom in 200 g or 500 g packs in polythene bags can be done with the help of a shrink wrap machine.

Fig. 5 Mushroom ready to harvest

5. **Critical input required:**

- Paddy straw
- Polythene bag
- Mushroom spawn
- Plastic rope

6. **Observation to be recorded:** Regular temperature and relative humidity, Pin head formation

7. **Target users/stakeholders:** MTTCs/ KVKs/Farmers

8. **Precaution(s) with the technology:** Do not dry the straw on the floor; Never sprinkle water on the bed for the first two weeks

9. **Advantage / Benefits / Utility of technology:** Opportunity for off- season

farming and extra income generation for the farmers

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 2.2

Production: Average production 5 kg d^{-1} (mid-June to mid-December)

S. No.	Cost and profit	Amount (Rs.)
1	Non recurring and fixed capital	30,000
2	Fixed cost	4,000
3	Recurring cost (paddy straw, polythene bags, labour, spawn etc.)	25,000
4	Total cost of the mushroom production (2+3)	29,000
5	Total income (400 kg @ 200)	80,000
6	**Net Profit (5-4)**	**51,000**

11. **Technology developed under the project:** ICAR-AICRP on Mushroom, CHF (CAU, Imphal), Pasighat

12. **Investigator(s)/inventor(s):** R. C. Shakywar, P. Raja and B. N. Hazarika: Email: rcshakywar@gmail.com; prajachf@gmail.com, Mobile: 9402477033; 9436250901.

13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312.: Chapter 04: Technology No. 11: Mushroom Cultivation in Arunachal Pradesh: 140-144.

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TECHNOLOGY:
NECTAR-CP-26

1. **Name of the technology:** Management and rejuvenation of citrus orchard of North East Region
2. **Source of the technology:** CHF and KVK- ES (CAU, Imphal) Pasighat, Arunachal Pradesh
3. **Year of adoption/ development:** 2012
4. **Description of technology with salient features:**

Citrus is the second most important fruit crop of the world in terms of area, production and utility. India with the production of 6 million tons occupies sixth position in the world. There are four distinct citrus growing regions in the country *viz*. North east region comprising of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, North western region comprising of Himanchal Pradesh, Punjab, Haryana and Rajasthan, Central region including Gujarat, Maharashtra & Madhya Pradesh and Southern region comprising of Andhra Pradesh, Karnataka and Tamilnadu. North east region of India is ~~the~~ natural home to different citrus species. Mandarins (*Citrus reticalata*), sweet orange (*C. sinensis*), acid lime (*C. aurantifolia*) and lime (*C. limon*) are the major cultivated species of the region. Although, citrus is widely grown fruit crop in north east region of India, the productivity is very low with 4.54 t ha^{-1} as against the national productivity of 8.42 t ha^{-1}. One of the main reasons of low productivity is attributed to losses caused by diseases *i.e.* fungal, bacterial, viral and phanerogamic plant parasites and insect-pest. The growers do not adopt proper management practices in terms of plant protection, manuring, irrigation, mulching, pruning etc. as a result the productivity is affected and the orchards become sick.

Rejuvenation strategies:

The following strategies are proposed for rejuvenation and month wise calendar of management practices is provided which should be followed for higher productivity.

- Re-planting of old / uneconomically orchards should be practiced.
- Gap filling and replanting should only be done with disease free quality seedlings.
- Training is an important component, which improves overall efficiency and knowledge and skill of field functionaries.
- Complete technological information for the management of decline orchard may be packed and same be disseminated by farm' fields.

Months	Management Practices
January	• Cleaning of orchard followed by pruning of dead, diseased and overlapping branches immediately after harvest. • Treatment of pruned ends with 1% Bordeaux paste (1 kg lime dissolved in 5 l of water in the bucket do not use plastic & Iron, dissolve 1 kg copper sulphate $CuSO_4$ $5H_2O$ is another 5 l of water, mixed the solution well.) • Clean the lichen /mosses growth with a piece of gunny bag.

Months	Management Practices
February	• Locate trunk borer and plug the holes with mud after plugging cotton soaked in petrol/kerosene or carbon disulphide. • Cut the wither parts and destroy them. • Loranthus infected branches should be cut well below the last haustorium. The parasitic plant should be eradicated before the maturity of berry. • Orchard phytosanitation and basin preparation by light working of the soil without root injury.
March	• Apply 25 kg FYM/tree around the tree trunk and after 15 days apply Urea (800 g), Single Super Phosphate (400 g), and Muriate of Potash (800 g)/ tree. • Swapping of tree trunk with 1% of Carbaryl up to 2 m from base. • Spray endosulphan 0.07% to kill the adult trunk before feeding the foliage. • Shaking of tree to kill the adult trunk borer manually.
April	• Apply Bromocil 6 kg ha^{-1} to control weeds • Spray micronutrients mixture (Zinc sulphate 60 g, Manganese sulphate 40 g, borax 20 g and lime 180 g dissolve in 20 l of water) or spray agromin @ 15 g in 10 l of water. • Spray of Quinolphos 1.5 ml l^{-1} to control foliage feeder.
May	• Swapping of the base of the trunk with 1% Carbaryl and 1% of Bordeaux paste. • Install light trap to catch trunk borer adults or hands picks. • Apply 200 g of urea in the soil around the tree basin.
June	• Sow intercrops like French bean, Chilli or any leguminous crops. • If fruit drop problem occurs, apply light irrigation in orchard. • Clean the weeds in the entire orchard area manually.
July	• Spray Roger or Monocrotophos @ 1.5 ml l^{-1} of water if leaf minor damage appears. • Spray of Bordeaux mixture 1% (dissolve 1kg lime in 50 l water in plastic bucket + dissolve Copper sulphate 1 kg in 50 l water separately. Mixed two the solution and use within a day).
August	• Kill the grubs of trunk borer by hooking by spike. • Under severe infestation of trunk borer inject 5 ml Monocrotophos or Carbon disulphide / hole and plug with mud. • Cut and burn dried parts of the plants as they harbour grubs and pupae. • Apply 200 g of Urea /plant in soil application.

Months	Management Practices
September	• Apply Glyphosate 5 l ha^{-1} to weed control • Harvest the intercrop. • Use poison bait prepared by mixing 20 g Malathion 50 wp + 200 g Jaggery or molasses in 2 l water. Place in small plastic containers and hang 2-3 / tree for control of fruit sucking moths. • Generate smoke in the orchard @ 2-4 $acre^{-1}$ for 2-3 hours after night fall to control fruit piercing moth. • Dispose fallen fruits which attract the moth.
October	• Follow control methods (as September) to control fruit sucking moth. • Dispose fallen fruits which attract the moth. • Control of trunk borer may be repeated. • If pre-matured fruit drop problem occurs, spray 10 mg l^{-1} 2,4 –D or 15-20 mg l^{-1} Naphthalene acetic acid (NAA).
November	• Harvest the mature fruit without damaging the plant. • Cut the dried branches, if any and apply 1% Bordeaux paste at the cut ends.
December	• Harvest of matured fruits continued. • Harvest the fruits using secateurs, cutter or clipper avoid hand plucking. • Grade the fruit into too small, too big, rotten, damage, hard green, over ripe. • Wash the fruit at the packing shade with chlorine water and then rinse with fresh water. • Washed fruit should be treated with Benomyl or Bavistin @ 0.25% mix with wax. • Pack 50 fruits in one box or basket. Use chopped rise straw or dry grass for packing.

Rejuvenation Practices:

- Pruning of dried branches, after the harvest fruit immediately followed by application of Carbendazim (Bavistin) spraying @ 1 g l^{-1} of water.
- Control of bark eating caterpillar (Inderbela) by application of Dichlorovas @ 0.1% (3-5 ml) in each larval tunnel or inserting tunnel cotton swap soaked with insecticides.
- Scrapping of oozing out gum and application of Metalaxyl paste on the wound.
- Spraying of Ridomil MZ 72 WP @ 2.5 g l^{-1} for the control of Phytophthora.
- Irrigation by double ring method / drip and provide proper drainage.
- Application of recommended dose of fertilizer and micro-nutrients.

Fig. 1-8 Citrus Rejuvenation in Arunachal Pradesh

- Spraying of Imidacloprid (0.3 ml) or Monocrotophos @ 0.5 ml l^{-1} of water for the control of citrus psylla.
- Spraying of Dicofol @ 1.5 ml l^{-1} for the control of mites.
- Application of Bordeaux paste on the tree trunk twice a year before monsoon and after monsoon.

5. Critical input required:

- Pruning knife (Dao sterilized with fire)
- Bucket
- Foot sprayer
- Bordeaux paste
- Brush

6. **Observation to be recorded:** Yellowing of leaves, declining of tree, die back

7. **Target users/stakeholders:** MTTCs/ KVKs/Farmers

8. **Precaution(s) with the technology:** Prepare the ring basin around the tree before applying the material

9. **Advantage/ Benefits/ Utility of technology:** Increase in the yield of the citrus tree; Declining the pest and disease incidence

10. **Economics of the technology/ Benefit:** 15 to 25% yield in citrus trees.

11. **Technology developed under the project:** NA

12. **Investigator(s)/inventor(s):** R.C. Shakywar, P. Raja and B. N. Hazarika: Email: rcshakywar@gmail.com, Mobile: 9402477033

13. **Technology publication:**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 04: Technology No. 09: Citrus Rejuvenation: 133-137.

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TECHNOLOGY:
NECTAR-CP-27

1. **Name of the Technology:** Management of bacterial wilt of binjal, chilli and tomato in North East Region
2. **Source of the Technology:** CHF (CAU, Imphal), Pasighat, Arunachal Pradesh
3. **Year of adoption/development:** 2013
4. **Description of technology with salient feature:**

Wilt diseases of brinjal, chilli and tomato can be caused by fungal and bacterial pathogens (both are soil borne), as well as by abiotic factors. Bacterial wilt is predominant in North Eastern Region of India followed by Fusarium and Verticillium wilt. Determining which agent is responsible for causing disease is vital for prescribing the proper management strategies. The external and internal symptoms produced on the host by each pathogen; provides information on the disease life cycle and environmental conditions that favour disease development; and also provides basis for diagnostic techniques that can be used in the field diagnosis of each disease described.

Causal organism: *Pseudomonas solanacearum* or *Ralstonia solanacearum* (soil-borne bacterium)

Symptom: A characteristic of this disease, which sets it apart from other wilt diseases, is that plants wilt and die rapidly without the presence of yellowing or spotting of the foliage. The disease can occur in newly cleared land as well as in areas where susceptible crops have not been grown previously. The bacterium often enters a field on infested transplants, equipment, or through drainage water. The pathogen can overwinter in soil.

Entry of the bacterium: Bacteria infect plants through the roots or stem, most often where tissue has been injured by cultivating, or by some other physical means such as nematodes. Bacteria invade the vascular tissue, apparently causing wilt by a gradual blocking of the water conducting vessels.

Epidemiology: The disease is most commonly found in low, wet areas of fields and is most active at temperatures above 20-25^{0}C.

Identification of the bacterium: To identify bacterial wilt pathogen, cut and peal back a section of the epidermis and cortical tissue (bark) just above the soil line. The centre of the stem (pith) will, in early stages, appear water soaked; later, the pith will turn brown and sometimes become hollow. The discoloration of the pith distinguishes this disease from Fusarium and Verticillium wilt. Another relatively easy diagnostic technique is to cut a portion of the affected stem and place it in a clear glass container filled with water. The appearance of white, milky ooze streaming out of the cut end of the discoloured vascular tissue is diagnostic for this disease.

Host range:

Bacterial wilt attacks members of the Solanaceous plant family, which includes peppers, potatoes, and egg plant etc.

Control measures:

i Before sowing, the seeds should be dipped in a solution of Streptomycin sulphate (1 g 40 l^{-1} of water) for 30 minutes.

ii Soil fumigation with formaldehyde 0.5% should be done before sowing of seeds in the nursery beds.

iii Crop rotation is an effective method of control.

iv Soil solarization is another alternative for control of bacterial wilt.

v Roguing of wilted plants and the soil surrounding their roots can reduce spread of the disease and may be a viable control alternative in home garden situations.

vi Soil drenching with blitox 0.2%

Fig. 1 Wilt infected Tomato crop

Fig. 2 White milky ooze of bacterial wilt

Fig. 3 Healthy tomato crop

5. Critical inputs required:

- Streptomycine sulphate
- Blitox
- Formaldehyde

6. Observation to be recorded:

- Wilting symptom
- Drying of leaf

7. Target users/stakeholders: MTTCs/ KVKs/Farmers

8. Precaution(s) with the technology:

- Prepare accurate dose of fungicide or antibiotics
- After soil drenching with formaldehyde, cover it with transparent polythene sheet

9. Advantage/Benefits/Utility of technology:

- Reduce the disease incidence by 30 per cent

10. Economics of the technology/ Benefit: Increases the yield by 20-23%

11. **Technology developed under the project:** NA

12. **Investigator(s)/inventor(s):** R. C. Shakywar, P. Raja and B. N. Hazarika: Email: rcshakywar@gmail.com, Mobile: 9402477033

13. **Technology publication:**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 04: Technology No. 08: Management of Bacterial Wilt of Binjal, Chilli and Tomato in North East Region: 130-132.

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TECHNOLOGY:
NECTAR-CP-28

1. **Name of the Technology**: Zero tillage cultivation of rapeseed-mustard with bee pollination and non-chemical method of plant protection
2. **Source of Technology**: Directorate of Extension Education, CAU, Imphal, Manipur
3. **Year of adoption/development**: 2013
4. **Description of technology with salient features**:

Oilseed cultivation in the NEH region faces several constraints, such as water scarcity during post-monsoon season, lack of irrigation facilities, short time lag after rice harvest for seed sowing and high incidence of pests and diseases in late sown crops. As a result, only monocropping of rice is practiced and the farmers leave their land fallow.

The rapeseed-mustard is a climate resilient crop which can be grown with limited water and in residual soil moisture. For higher yields of rapeseed/mustard, the following technology should be followed:

a) **Variety**: The suitable varieties for Zero tillage cultivation are:

- Toria: TS-36, TS-38, TS-46 and TS-67
- Yellow sarson: Ragini and YSH-401
- Mustard: NRCHB-101

b) **Sowing time**: 15th October to 15th November is best. Sowing should be completed by 30th November without tillage in residual soil moisture.

c) **Seed rate**: 12 kg of seed ha^{-1}. Seeds may be mixed with sand (3 kg seed + 2 kg sand for 0.25 ha area) and broadcast.

d) **Seed treatment**: Seed treatment with *Trichoderma harzianum* (5 g kg^{-1} of seed) + liquid biofertilizer (10 ml kg^{-1} of seed) to reduce disease intensity and fertilizer dose particularly urea.

e) **Fertilizer Management**: In the present approach reduced fertilizer dose of 40:20:20 kg NPK ha^{-1} (88 kg Urea + 130 kg SSP +33 kg MOP) is recommended.

- Total quantity of SSP (130 kg) + half of MOP (16 kg) should be applied at or before sowing when there is moisture in the field. Urea should be applied in two splits, first half (44 kg) at seedling stage (when 1-2 true leaves emerged) and the remaining half (44 kg) mixed with the remaining quantity of MOP (17 kg) be applied at 25-30 days after first application/pre-flowering stage and one irrigation should be given.
- Spraying of Urea 3% is also very effective if irrigation facility is not available
- Use of Beltonite sulphur @ 15 kg ha^{-1} will increase 10% yield and 1% oil content

f) **Thinning:**

- Closely growing young plants may be thinned out to maintain a spacing of around 5-10 cm in both sides within one month of sowing. However, farmers prefer late thinning (when plants attain 10-15 cm height) as they earn additional income by selling those thinned out plants for culinary purposes.

g) **Plant protection (Non-chemical method)**:

- Rapeseed and mustard generally escape from serious problems of pests and diseases if the crop is sown early

- Infestation of aphid can be managed by application of Azadiractin (0.15% w/w) @ 3 ml l^{-1} or Azadiractin (0.03% w/w) @ 5 ml l^{-1} (eco-friendly neem karnel extract-quickly penetrating botanical insecticide) of water and spraying should be made in the evening hours
- Disease incidence can be managed by application of *Trichoderma harzianum* @ 10 ml l^{-1} of water or any organic pesticide

h) **Bee pollination**:

- By keeping 4 bee colonies ha^{-1}, seed yield can be increased up to 20% with 4% increase in oil content. Further, honey can be harvested 3 times during the crop bloom
- Four bee hives should be placed in 1 ha preferably in the centre of the field when crop shows 10% flowering. Some flowers may also be soaked in sugar syrup (1:1 sugar water mixture and fed to the bee colonies in the previous night before transporting them for immediate initiation of foraging

i) **Harvesting**:

- The crop should be harvested when the lower siliqua has a dried appearance with yellowish colour and about 25% of the upper siliqua still have pale green colouration.

5. Critical inputs required: Seeds, fertilizers, biofertilizer, biopesticides and bee hives.

Fig. 1 Zero tillage cultivation of Indian mustard, NRCHB-101

Fig. 2 Zero tillage cultivation of rapeseed, TS-38

Fig. 3 Use of bee colonies for pollination

Fig. 4 Honey extraction in the mustard field

6. **Observations to be recorded**:

- Yield parameters
- Oil content
- Seed yield
- Honey yield
- Farmers' reaction
- B:C ratio

7. **Target users/stakeholders**: Multi Technology Training Centres (MTTCs)/ KVKs/ Farmers

8. **Precaution(s) with the Technology**:

Zero tillage should be practiced depending on the following:

- Soil type
- Soil moisture condition
- Field situation
- Suitability of the field

9. **Advantage/ Benefits /Utility of Technology**:

- By adopting the technology, the farmers can ensure seed sowing in time just after rice harvest, reduced cost of cultivation and increased net profit, increased the cropping intensity and earned additional income from organic honey.
- Zero tillage also helps in conserving soil moisture and requires less water, saves tillage cost and time and the soil is protected from erosion due to the retention of surface residues and reduce organic matter depletion.

10. **Economics of the Technology/ Benefit: cost ratio**: 1: 3.3

11. **Technology developed under the project**:

TSP project entitled "Augmenting Rapeseed-Mustard production of Tribal Farmers of North Eastern States for sustainable livelihood security" funded by ICAR, New Delhi.

12. **Investigator(s)/Inventor(s)**:

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13. **Technology Publication(s):**

Singh, M. P., Chongtham N., Singh, T. R. and Devi T. R. (2013). Zero tillage cultivation of rapeseed-mustard - A way to sustainable production, *DEE Technical Bulletin* 3, pp. 9.

Singh, M. P., Singh, T. R., Devi T. R. and Chongtham N. (2013). Zero tillage cultivation- A viable option for large scale production of rapeseed-mustard in rice fallow, *APAARI Newsletter*, **22**(2): 12-13.

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TECHNOLOGY:
NECTAR-CP-29

1. **Name of the Technology:** Mass production of plant growth promoting rhizobacteria agent for management of seed and soil borne diseases of tomato, chilli, cabbage cauliflower and citrus.
2. **Source of technology:** CHF (CAU, Imphal), Pasighat, Arunachal Pradesh
3. **Year of adoption/development:** 2014
4. **Description of technology with salient features:**

Soil and seed borne diseases are posing a major threat to solanaceous vegetable and citrus crop. Native Plant Growth promoting rhizobacteria such as *Pseudomonas putida* is the best option to control the seed borne and soilborne pathogen. Plant Growth Promoting Rhizobacteria isolates were collated from different parts of Arunachal Pradesh and their potentiality was checked under *in vitro* and *in vivo* conditions. Out of forty-five isolates collected, CHF 2011 32 and TRB were recorded to be the best for management of seed and soil borne diseases of tomato, chilli, cabbage, cauliflower and citrus. Bacterial bio-control agent *Psedomonas putida* was mass multiplied and released as PASIPUSA by College of Horticulture and Forestry, Pasighat to manage soil borne pathogenic bacteria and citrus canker.

5. **Production procedure Mass multiplication of PGPR bio-formulation-**

- PGPR isolates *P. putida* is mass multiplied in sterilized king's B broth for 48 hours.
- KING'S B Broth Preparation:
- Peptone: 20.00
- Heptahydrated Magnesium Sulfate: 1.50
- Di Potassium Hydrogen Phosphate: 1.50
- Final pH 7.2± 0.2 at 25ºC

The above chemicals were mixed in one litre of distilled water. Added 10 ml of glycerol and dissolved by heating with frequent agitation. Boiled for one minute until complete dissolution. Dispense into conical flask, and sterilized in autoclave at 121ºC for 15 minutes. The colour is amber, slightly opalescent. A loopful of bacterium was inoculated into the Kings B broth culture under aseptic condition. The bacterial culture is mixed with sterilized talcum powder (pH is adjusted to 7 by adding calcium carbonate @ 150 g kg^{-1}). The substrate is then sterilized at 1.1 kg cm^{-2} pressure for 30 min for two successive days. Four hundred ml of 48 h old culture suspension of *P. fluorescens* was added to 1 kg of substrate containing 5 g of carboxymethyl cellulose (CMC) and mixed well. Finally, the talc based bioformulation was packed in polythene bags and can be stored at room temperature for six months

Critical input required:

Talcum powder, rhizobacteria culture, polythene, carboxymethyl cellulose (CMC)

6. **Observation to be recorded:**
   a. Quality of the medium
   b. Microbial population at the end product
   c. Viability of the PGPR
7. **Target users/stakeholders:** MTTCs/KVKs/Farmers

Fig. 1 Releasing of PGPR as PASI PUSA during Agri Horti-Expo, 2014

Fig. 2 Spraying of PGPR at College Orchard

Fig. 3 Awareness training about Citrus Management at Renging Village

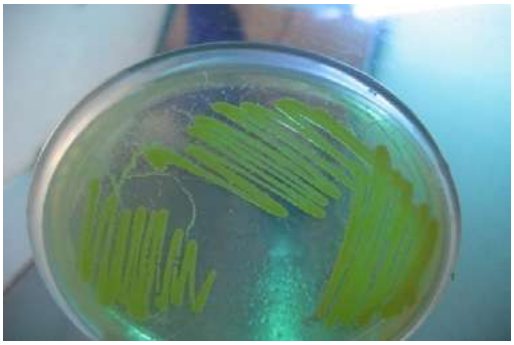

Fig. 4 Plant Growth Promoting Rhizobacteria production

8. Precaution(s) with the technology:

- Set the optimum incubation temperature
- Wear mask while preparing the mixture

9. Advantage/Benefits/Utility of technology:

- Reduce the disease incidence by 22 to 30%
- Increase the crop yield by 15 to 20%

10. Economics of the technology/ Benefit: Cost Ratio: BC ratio is 1: 2.2

11. Technology developed under the project:

DBT, GOI funded project entitled "Plant growth promoting Rhizobacteria for the management of major seed borne diseases and enhancement of seed quality of vegetables and planting materials for north eastern region of India"

12. Investigator(s)/ inventor(s):

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13. Technology publication(s):

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K, Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter- 02: Technology No. 13: Mass production of Plant growth promoting rhizobacteria agent for management of seed and soil borne disease of tomato, chilli, cabbage cauliflower and citrus, 146-148.

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TECHNOLOGY:
NECTAR-CP-30

1. **Name of the technology:** Organic management of soft rot of ginger
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Manipur
3. **Year of adoption/development:** 2014
4. **Description of technology with salient features:**

Ginger is one of the earliest known oriental spices and is obtained from the rhizomes of *Zingiber officinales*. The ginger family isatropical group, especially abundant in Indo- Malaysian region, consisting of more than 1200 species in 53 genera. Ginger production is showing steady decline in recent times mainly due to rhizomerot and insect root or shoot borer in the major production areas in Manipur. This has led many growers to abandon ginger cultivation. The present technology will provide management of ginger rot under organic cultivation system. Adoption of this technology has shown increased germination percentage, plant height, yield (25.23% over control) and reduced ginger rot incidence.

Methodology:

- Dip rhizome pieces in hot water at 47˚C for 30 minutes before planting.
- Rhizome treatment with *Trichoderma* spp. @ 10 g kg^{-1} seed or Rhizome seed pieces in 5% Garlic extract for 2 h and allow airing dry prior to planting and allowing to air dry prior to planting.
- Soil drenching with Garlic extract (5%), 20 days interval, 3-4 times after planting reduce the rhizome rot incidence and also increase the yield.

Fig. 1 Ginger at experimental area

Fig. 2 Hot water treatment of Ginger Rhizome

Quality character:

The produce is organic and fetches higher price. The rhizomes will be healthy with high storability.

5. **Critical inputs required:** Water, Drum, iron mesh, thermometer, Rhizome, *Trichoderma,* Plant extracts.
6. **Observation to be recorded:**

- Seed germination percentage

- Agronomical traits
- Disease incidence.
- Yield.

7. **Target users/stakeholders:** Organic farmers/producers.

8. **Precaution (s) with the technology:** a) Care should be taken for the source of *Trichoderma* (viability, etc.),

   b) Maintaining the right temperature and duration for heat treatment.

9. **Advantage/ Benefits/ Utility of technology:**

   As the disease is serious and difficult to manage in organic way, the technologies

- Hot water treatment is a simple and if trained it can easily be accessible by the farmers in remote areas particularly hill regions.
- It is more economic as compared to chemical treatments in addition to unavailability of the latter.
- It prevents the disease from establishment in the soil of organic farms and from developing as seed borne disease.

10. **Economics of the technology/Benefit: Cost Ratio:**

    It is highly economical for the organic ginger producers both for rhizhome and seed once the system established with the farmers. The initial C: B ratio is 1: 1.5.

11. **Technology developed under the project:** ICAR funded 'Network Project on Management of Soft Rot of Ginger'.

12. **Investigator(s)/inventor(s):**

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13. **Technology publication(s):**

    Annual Report of the Network Project on Management of Soft rot of ginger, sponsored by ICAR, 2014.

    CAU Annual Research Report, 2011-12 (Page no. 33).

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TECHNOLOGY:
NECTAR-CP-31

1. **Name of the technology:** Techniques for production of virus free planting materials in *khasi* mandarin
2. **Source of the technology:** CHF (CAU, Imphal), Pasighat, Arunachal Pradesh
3. **Year of adoption/development:** 2014
4. **Description of technology with salient features:**

Selection of rootstock: *Khasi* mandarins are generally propagated through seed. However, due to various disadvantages like variation in fruiting, fruit size, delay in flowering and quality characters selections of rootstock are necessary. Rough lemon (more tolerant to salts and tolerant to tristiza virus (CTV), citrus exocortis viroid (CEV) and citrus xyloporosis viroid) and Rangpur lime (resistant to citrus tristiza virus (CTV) and tolerant to drought, high saline and calcarious soil condition) are the common rootstock used for the propagation of *khasi* mandarin.

Growing of rootstock seedlings:

Seed treatment: Seeds of most citrus species are recalcitrant in nature. Their viability during storage varies depending upon species and storage condition. Seedlings in the seed beds are suffered from *Phytophthora infection* causing damping–off disease during the rainy season. Therefore, seeds should be treated with a fungicide like captan or thiram (1 g kg^{-1} seed) to reduce the infection before the sowing.

Seed germination: 3-4 weeks onwards seeds starts germination and 3-4 months after germination seedlings ready to transplant to the polythene bag. Polythene bag filled with Soil: FYM: Sand @ 2:1:1 ratio. Such transplant plants are ready for budding when they are pencil thickness size of the stem usually 7-8 month after transplant to the polybag having 20-25 cm height from the ground level.

Care of rootstock seedling: After the germination, it should be regularly sprayed with insecticide monoctrotophos @ 1.5 ml l^{-1} or profex @ 1.5 ml l^{-1} of water to control pests particularly citrus leaf miner and quinalphos @ 2 ml l^{-1} of water to control citrus lemon caterpillar. Soil drenching with blitox or Copper Oxychloride @ 2 g l^{-1} to control the damping off. Further, more weed infestation are there particularly after the rainy season so frequent hand weeding should be done to control the weed.

Selection of mother plant (Scion): The mother plants for the budding should be healthy, precocious and heavy bearing, free from pests and diseases infestation. Important criteria for the selection of mother plants are: It should be vigor, precocious and regular bearing, high yields and good fruit quality. Selected plants should be indexed against diseases particularly tristiza virus which cause quick citrus decline through ELISA test. Mother plants should be grown under insect proof screen house.

Budding: Mandarin are commercially propagated through 'T' budding. However, at present 'I' budding preferred instead of 'T' budding since this method caused less injury to the plant system as compared to 'T' system.

Wrapping period: After 'I' shape dormant bud scion are inserted inside the cut in the rootstock portion about 10-15 cm above the ground are wrapped with plastic polythene binding from bottom portion and move upward with 200 gauge polythene strips of 1.2 to 1.8 cm width. After the scion is wrapped

tightly it must be kept under the partial shade net house condition for 21 days and should be open after 21days. If it is successful cutting down the rootstock 5 cm above the budded joint and allowed the scion to grow up.

Budding period: Seedling of the Rangpur lime when attain the height of 20-25 cm from the ground level and its flaps are lifted easily with the help of budding knife during the period of January -March are selected for budding with scion which dormant bud can be easily removed from the bark without the wood portion.

To produce the quality planting materials for budded *khasi* mandarin plant, rootstock of rangpur lime or rough lemon of pencil thickness size should be use and the scion should be collected from the healthy mother plant free from viral disease (Tristiza) and should be tested with ELISA test before budding. Under Pasighat, East Siang district conditions January-March are suitable for successful budding.

Fig. 1 Rangpur lime rootstock

Fig. 2 Scion collected from healthy mother plants

Fig. 3 Budding operation

Fig. 4 Successful budded plants

5. **Critical inputs required:**
   - Rootstock (seed Rangpur lime and Rough lemon
   - Selection of virus free mother plant
   - Selection of favourable budding period
   - Selection of budding method
6. **Observation to be recorded:**
   - Damping off in the seedling stage
   - Sap flow stage for rootstock and scion having pencil thickness size
   - Successful % of budded plant.

7. **Target users/stakeholders:** MTTCs/ KVKs/Farmers/SHGs/NGOs

8. **Precaution(s) with the technology:** Precaution must be taken in selection of scion stick. The bud should be selected from fairly well mature non- bearing current years shoots having round twigs longitudinal white streak on the bark and swollen buds ready to grow. Bud wood should be kept in moist sphagnum moss and gunny bags to avoid exposure desiccation. The condition of active sap flow is important consideration for success of budding in *khasi* mandarin.

9. **Advantage/ Benefits/ Utility of technology:**

- Budded plants start fruiting at lower height as compared to seedling plants
- Budded plant of *khasi* mandarin with rangpur lime are resistant to citrus tristiza virus (CTV) and drought resistant.
- It starts reproductive in early stage as compared to seedling *khasi* mandarin.

10. **Economics of the technology/ Benefit: Cost Ratio:** Production of budded plants of *khasi* mandarin is economically viable technology provided facility and skill work together. The cost benefit ration may go upto 1: 3.5.

11. **Investigator(s)/inventor(s):** B. N. Hazarika and S. Romen Singh: Email: bnhazarika13@yahoo.co.in; Mobile: 7005108240

12. **Technology developed under the project:**

Ministry of Agriculture& Farmers Welfare, GOI funded Mini Mission-1 project entitled "Technology Mission on Integrated Development of Horticulture for North Eastern States".

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TECHNOLOGY:
NECTAR-CP-32

1. **Name of the technology:** Use of rice husk ash in controlling insects in stored soyabean seeds
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Manipur
3. **Year of adoption/development:** 2017
4. **Description of technology with salient features:**

Storing of seeds after their harvest has always been a problem for the next season sowing and often found to be infested with pulse beetles/weevils. Many of the farmers do not have the knowledge of using chemicals or they do not get it in time as well as expensive. Also use of chemicals in organic cultivation is strictly prohibited, therefore the proposed method of storing seed meets the requirement of organic cultivation.

Fig. Soyabean

The process starts with drying of the freshly threshed seeds spread thinly on a concrete floor or polythene sheet or gunny bags or tin sheets, etc., for 5 days under the hot sun. It should be cooled down and stored in polythene bags or metal container. The seeds are mixed with rice husk ash at the ratio 250 g kg^{-1} seed before storing in the storage containers. A thick layer of ash is spread on the top of the seed so that the seeds are not exposed to open air. and the bags should be tide it strongly. This technique could be used for black gram, maize and pea too. Its technology useful for management of storage pests.

5. **Critical inputs required:**
   - Rice husk ash
   - Any bags or container
6. **Observation to be recorded:** NA
7. **Target users/stakeholders:** MTTCs/KVKs/Farmers
8. **Precaution(s) with the technology:**
   - The Seeds should be dried properly in the sun for 5 days.
   - The ash should be rice husk only as because it contains about 96% of SiO_2.
   - Ashmust be mixed properly with the seeds.
   - Top portion of the seeds should be covered with a thin layer of the ash.
9. **Advantage/Benefits/Utility of technology:**

- Low cost
- Easy for the farmers and also organic in nature
- Eco-friendly
- Seeds can be stored up to one year.

8. **Economics of the technology/ Benefit: Cost Ratio:** It is a local technology as rice husk is freely available in Manipur.

11. **Technology developed under the project:** NA

12. **Investigator(s)/inventor(s):** M. Sumarjit Singh**:** Email: msumarjit@yahoo.com; Mobile: 9436892055.

13. **Technology publication(s):**

Singh, M. S. and Devi, Th Anupama (2020). Effects of rice husk ash on controlling insect pest on storage of soybean under Manipur condition. *International Journal of Chemical Studies*, **8**(1): 1866-1868. (DOI: 10.22271/chemi.2020.v8.i1aa.8536). (NAAS Rating – 5.31).

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TECHNOLOGY:
NECTAR-CP-33

1. **Name of the technology:** Mass production of *Trichoderma* at low cost using agricultural waste

2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Imphal, Manipur

3. **Year of adoption/development:** 2018

4. **Description of technology with salient features:**

   Trichoderma is one of the important and widely used bio-control agents worldwide. Soil-borne diseases *viz., Fusarium*, *Rhizontonia*, *Pythium*, and *Sclerotium rolfsii* are common diseases for crop production in NE Region due to high rainfall. These pathogens are not only difficult to control using chemicals but also the application of the chemicals contaminate the soil. Therefore, *Trichoderma* is one of the most effective and eco-friendly bio-agent against these diseases. The present technology will help the farmers to understand the use of the bio-agents and learn the low-cost mass production of their own from the locally available resources. The details of the methodology are given below:

- Make 50 g mixture of rice bran and saw dust in the ratio of 1:1 weight/weight, and fill a polypropylene bag (approx. size 15 x 20 cm^2).
- Add 5 to 10 g dextrose/sugar/sugarcane juice in a polypropylene bag and seal with cotton plug using rubber band.
- Sterilize the filled polythene bags in an autoclave at 121˚C (15 psi 15 lb^{-1} in^{-2}) for 15 min or in a pressure cooker (whistle 3 to 4 times).
- Five to seven days old young culture of *Trichoderma* spp. are cut to half with the help of inoculation needle.
- The cut mycelial mats are inoculated to the sterilized mixture packets, then keep for few days till it starts sporulation (green colour appear).
- Seed /Tuber/Rhizome treatment: 5 g kg^{-1} of seed.
- Seedling/Cutting treatment: Prepare suspension of 5-10 g l^{-1} of water. Deep the seedling or the cuttings into the suspension for 1 to 2 h.
- Direct broad casting: 500 g for one acre of land. Mix 500 g in 12 kg of FYM. Broadcast in one acre of land and irrigate the field.

5. **Critical inputs required:**Rice bran, *Trichoderma* culture, sugar candle, pressure cooker, polypropylene bag, cotton, rubber band

6. **Observation to be recorded:**

- Seed germination
- Agronomical traits
- Disease incidence
- Yield

7. **Target users/stakeholders:** Farmers/ SHGs/NGOs

8. **Precaution (s) with the technology:**

1. Care should take while handling or preparing the product such as:

   a) Should not be excess moisture.

   b) Should not be low moisture- it will

Fig. 1 Weighting and packaging of the substrate (1:1)

Fig. 2 Sterilization of the substrate in the autoclave or pressure cooker

Fig. 3 Inoculation of *Trichoderm*a culture to the substrate & kept for growth

hamper in the numbers of Trichoderma in the medium.

2. During preparation or field application it should not be directly expose to sun.

9. Advantage/ Benefits/ Utility of technology:

- Low cost production technology of *Trichoderma* spp.
- Can easily produce by individual farmer when needed.
- Generate income by individuals, farmers and farmer's community.
- Can be produce from the locally available resources.
- Useful in organic disease management.
- With very less inputs, it can be produced.

9. Economics of the technology/ Benefit: Cost Ratio:

For small scale start up total investment of Rs 100 kg^{-1} approximately, this is non- recurring expenditure. Raw material inputs provided were easily available agricultural byproduct. For 1-ton capacity of production, its expected profit margin is 0.9 or 90%. The benefit cost ratio is approximately 1: 1.15.

10. Technology developed under the project: DST project entitled 'Mass production of native *Trichoderma* spp. with locally available agricultural waste or substrates and its promotion among the vegetable growers in Manipur'.

11. Investigator(s)/inventor(s): Bireswar Sinha and Ph. Sobita Devi
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12. Technology publication(s):

Sinha, B., Bhagat, S., Pramesh Kh. and Devi, Ph. Sobita (2016). Mass production of the *Trichoderma viride* with locally available materials from Tripura. *Plant Disease Research*, **31**(1): 106-108.

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TECHNOLOGY:
NECTAR-CP-34

1. **Name of the technology:** Insect trap with indigenous ash hen's feather and methyl eugenol for the control of fruit fly (*Bacterocera dorsalis*)
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Manipur
3. **Year of adoption/ development:** 2020
4. **Description of technology with salient features:**

Bactrocera dorsalis, previously known as *Dacus dorsalis* and commonly referred to as the oriental fruit fly, is a species of tephritid fruit fly that is endemic to Southeast Asia. The adult, which is noticeably larger than a house fly, has a body length of about 8.0 mm; the wing is about 7.3 mm in length and is mostly hyaline. The color of the fly is very variable, but there are prominent yellow and dark brown to black markings on the thorax. Maggots bore into semi-ripen fruits decaying them and ultimately dropping of fruits. Oozing of fluid and brownish rotten patches on fruitsare the other symptoms observed of fruit fly infection. Pheromone traps are ideal means of controlling as it will avoid using of toxic chemicals on fruits. We have developed indigenous pheromone trap that is made by cutting 1/3rd of the empty mineral bottles from the top. The bottom portion of the bottle is filled with plain water upto 4 inches. A bottle cap filled with 2 ml of methyl eugeno l/3 g of hen's feather ash is allowed to float on the water in the bottle. The top portion of the bottle is placed in inverted position in order to prevent the escape of the trapped flies. The trap is placed in the field by tying over a bamboo stick fixed in the soil and maintained the trap at the height of one feet above the crop canopy. Twenty-five such traps are required per hectare at the spacing of 10 m x 10 m. The technique is already popular with the farmers of both hill and valley districts of the state. Comparative study has indicated that the significant results generated from the present investigation revealed that methyl eugenol Lure trap proved to be superior to other materials with the mean fruit fly catch of 850.80 trap d^{-1}. The fields with Methyl eugenol lure trap (25 traps ha^{-1}) had net benefit of Rs. 25,000 ha^{-1} over the fields where farmers' practices were followed.

Table 1 Trapping efficiency of four luring materials for fruit fly, *B. dorsalis* control in cucurbitaceous crops

Days after application	Mean adult flies trapped per trap*			
	Methyl Eugenol	Protein Hydrogelate	Green leaves of *Artemisia nilagirica*	Green leaves of *Cinnamom/tamala*
1st day	245.50	105.45	65.56	89.75
2nd day	300.45	225.25	64.75	79.52
3rd day	356.34	265.65	72.85	83.45

4th day	450.25	267.44	76.29	87.65
5th day	560.54	269.49	82.11	90.23
6th day	756.25	273.34	80.35	87.66
7th day	850.80	286.55	76.77	85.43
Mean	**502.88**	**241.88**	**74.10**	**86.24**

*Mean of five replications

Fig. 1 Different stages for making fruit fly pheromone trap

5. **Critical inputs required:**

- Methyl eugenol
- Plastic bottle
- Ash hen's feather

6. **Observation to be recorded:**

- Attraction of fruit fly per trap
- Incidence of fruit fly in mango plant
- Yield

7. **Target users/stakeholders:** MTTs/ KVKs/Farmers

8. **Precaution(s) with the technology:**

- Timely installation of pheromone trap.
- Timely change of pheromone trap.

9. **Advantage/ Benefits/ Utility of technology:**

- It's an organic method of fruit fly control.

10. **Economics of the technology/Benefit:** 1: 3.42 cost-benefit ratio

11. **Technology developed under the project:** Central Agricultural University funded Intramural Research Project (IRP).

12. **Investigator(s)/inventor(s):**

    K. I. Singh and M. Premjit Singh: Email:singhki_ento@yahoo.com; Mobile: 9436890556.

13. **Technology publication:** Annual Report, CAU, Imphal

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TECHNOLOGY:
NECTAR-CP-35

1. **Name of the technology:** Integrated pest management in rainfed rice production system

2. **Source of technology:** COA (CAU, Imphal), Iroisemba, Manipur

3. **Year of adoption/development**: 2009/2020

4. **Description of technology with salient features**: Gall midge and blast are the key pests in rainfed rice production system and management of these serious pests through pesticides alone cannot achieve desirable results. Moreover, the occurrence of a new virulent rice gall midge biotype 6 has been reported by the investigators in Manipur and for the first time in India. In this context, the investigator developed an IPM module for effective management of major insect pests of rice in the NEH region.

These pests can be controlled through all round approach; i.e. adopting integrated pest management practices. Cultivation of insect and disease resistant varieties is one of the major components of integrated pest management currently adopted in several rice growing countries.

Components of IPM module:

- Use of CAU Selection-1, a variety resistant to gall midge and blast
- Seed treatment with *Trichoderma harzianum* (5 g kg^{-1} of seed)
- Planting during optimum recommended time, preferably in July
- Optimum plant population (spacing 20 x 15 cm)
- Balanced and split application of nitrogenous fertilizer, kg ha^{-1} (N, P, K @ 60 : 40 : 30 - 30 : 40 : 30; N, P, K as basal + 15 kg N at maximum tillering stage + 15 kg N at panicle initiation stage)
- Adoption of good agricultural practices (GAP)
- Regular pest monitoring (Use of pheromone traps @ 8 traps ha^{-1} for yellow stem borer)
- Need based application of insecticides:
    1. *T. japonicum* @ 50000 ha^{-1} to be released eight times at weekly interval starting from 30 days after transplanting of paddy. The release of *Trichogramma* to coincide with the egg laying period of rice stem borers.
    2. Use of insecticide like emematin benzoate @ 0.4 ml or indoxicarb 0.3 ml l^{-1} of water for management of rice pests.

5. **Critical inputs required**: Seeds, fertilizers, pheromone traps and pesticides

6. **Observations to be recorded**:

- Incidence of insect pests and diseases
- Natural enemies
- Population dynamics
- Grain yield
- Farmers' reaction
- B : C ratio

7. **Target users/stakeholders**: Multi Technology Testing Centres (MTTCs)/ KVKs/Farmers

8. **Precaution(s) with the Technology**: Timely application of pesticides based on economic threshold levels

Fig. 1 CAU Selection – 1, a variety resistance to gall midge and blast used in IPM treatment, Imphal

Fig. 2 Observation on moth catches in pheromone traps at Moidangpok, Imphal

Fig. 3 IPM treatment at Lamsang, Imphal

Fig. 4 Farmers' practice treatment at Ngairangbam, Imphal

9. **Advantage/ Benefits/ Utility of Technology**:

   Demonstration of this technology on 200 ha covering 4 districts of Manipur for on-farm verification through whole village approach has shown reduction of rice pest incidence in the region'

10. **Economics of the Technology/ Benefit: Cost ratio**: 1: 2.1

11. **Technology developed under the project**: World Bank aided National Agricultural Technology Project (NATP) entitled "New approaches to Integrated Pest Management in rainfed rice-based production systems" funded by ICAR, New Delhi.

12. **Investigator(s)/Inventor(s)**: M. Premjit Singh: Email: mpremjit55@gmail.com

13. **Technology publication(s)**:

Katti, G., Pasalu, I. C. Dani, R. C., Bora, D. K., Singh, M. P., Satpathy, C. R, Reddy, P. S and Venkateswarlu, B. (2006). Integrated Pest Management in Rainfed Rice Production Systems in India - A farmers' participatory study. *Oryza*, **43**(4): 296-304.

Pasalu, I. C., Katti, G., Dani, R. C., Bora, D. K., Singh, M. P. Satpathy, C. R., Reddy, P. S., Rao, G. G. S. N. and Venkateswarlu, B. (2004). Integrated Pest Management in Rainfed Rice Production Systems. Technical Bulletin No. 10. DRR, Rajendranagar, Hyderabad, pp. 47.

Singh, M. P. (2009) Rice insect pest complex in the current scenario of climate change in the north-eastern region. *In:* IPM strategies to combat emerging pests in the current scenario of climate change, V. V., Ramamurthy, G. P. Gupta, and S. N. Puri (eds.), Pub: Entomological Society of India, New Delhi, pp. 262-276.

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Chapter - 4

ANIMAL HUSBANDRY (AH) 10 technologies

TECHNOLOGY:
NECTAR-AH-36

1. **Name of the technology:** Low cost housing system for quails
2. **Source of the technology:** CVSc&AH (CAU, Imphal), Aizawl, Mizoram
3. **Year of adoption/ development:** 2007
4. **Description of technology with salient features:**

Fig. 1 Conventional wire-mesh cages for quails

Quails in general are reared in wire-mesh cage having angle iron structure (**Fig. 1**). In this system of housing, initial cost investment is high which may lead to high cost of production of quails. Moreover, separate feeding and water trough is required and are not available locally.

Therefore, it is difficult in getting the materials at a cheaper price. Bamboo and wood being abundantly available in Mizoram and in the Northeastern states which can be used in place of wire-mesh so as to make the structure eco-friendly. In this way, quails can be easily reared in cages made from bamboo and wood (**Fig. 2-5**) for getting better return by the farmers as compared to other cages i.e., perimeter cage and wire-mesh cage.

Specifications:

Bamboo cages for quails:

The cages consist of four tiers and each compartment can hold twenty-five birds. The size of each compartment is 3 ft long, 2 ft wide and 1 ft high. The height of the cage is 5 ft. Wood is used for the frame/structure. Pieces of bamboo and perimeter net were nailed to it for wall and floor.

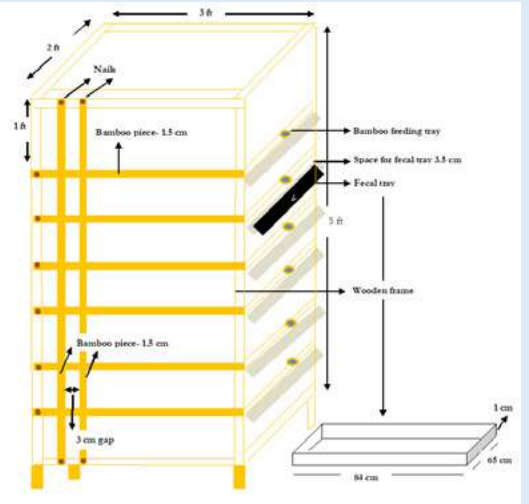

Fig. 2 Line diagram of low-cost bamboo cage (vertical) with dimensions for quail rearing

Spacing between bamboo pieces:

Bamboo are cut into pieces of about 1.5 cm wide which are nailed in the wooden frame**,** leaving a gap of about 3 cm in between the bamboo pieces. This bamboo pieces are placed either horizontally or vertically.

Fecal tray:

- Space for fecal tray : 3.5 cm
- Breadth : 65 cm
- Size : Length : 84 cm
- Over– edge : 1cm

Fig. 3 Recommended Bamboo cage (Vertical)

Fig. 4 Bamboo cage (Horizontal)

Fig. 5 Fecal tray

5. **Critical inputs required:**

- Quality and matured bamboo
- Big bamboo for feeding and watering trough
- Thick plain sheet for fecal tray

6. **Observation to be recorded:**

- Feed intake
- Age at first laying
- Number of eggs produced by the quails.
- Weight of quails
- Weight at first laying

7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs/Farmers

8. **Precaution (s) with the technology:** While making the bamboo into pieces, care should be taken that it should be of uniform size. The cut edge should be smoothened to avoid injury. The spacing of the cut piece of bamboo should be maintained so that the head can easily pass through in between the piece of bamboo.

9. **Advantage/ Benefits/ Utility of technology:** The quails kept under Bamboo cage was found to grow faster with higher feed efficiency and returned significant amount of profit compared to other housing systems. Moreover, placing the bamboo vertically is found to be more advantageous from the managemental point of view. This is due to convenient in the adjustment of the water and feeding trough height according to the size of the quails.

10. Economics of the technology/ Benefit: Cost Ratio:

Parameters	Bamboo cage
Average age at 1st lay	6wks 5 days
Average weight at 1st lay (g)	213.09
Egg production wk^{-1} $bird^{-1}$	5.42
Total feed intake per bird (g)	558.18
FCR	3.13
Total gain (g)	178.14
Cost kg^{-1} (Rs)	63.77
Profit kg^{-1} (Rs)	63.77

Technology developed under the project:

DBT, GOI funded project entitled "Studies on the potentials of quails farming in Mizoram".

9. Investigator(s)/inventor(s):

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10. Technology publication:

Anon. (2010). Technology recommended in ISAPM National Symposium held at AAU, Khanapara in 2010.

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TECHNOLOGY:
NECTAR-AH-37

1. **Name of the technology:** Early weaning and rebreeding in Large White Yorkshire pigs

2. **Source of the technology:** CVSc&AH (CAU, Imphal), Aizawl, Mizoram

3. **Year of adoption/ development:** 2014

4. **Description of technology with salient features:**

   - Under normal condition of rearing, piglets are weaned between 50-56 days of age and the sow is bred again in 2nd post weaning heat, leading to a lesser number of weaner pig production per sow/year compared to early weaning management.

   - Under the new method, piglets from the sow are weaned between 28-35 days of age and are reared under hygienic environment with provision of brooding (extra heat) and good feeding so that there is less mortality in weaned pigs. To maintain temperature of 25 to 27ºC in weaner pen, electric bulb or heater should be used. To keep the floor dry, slated floor made up of wood or iron or plastic should be used. Feed provided to the piglet should preferably be cooked one, which must contain 20 to 30% skimmed milk powder. Germ free drinking water should be provided ad-lib to the piglets. Piglets suffering from diarrhoea should be immediately treated with antidiarrhoeal drugs and electrolytes. The sow so weaned will normally come into heat/estrus within 5-7 days and are bred again in the 1st post weaning heat/estrus with boar or through Artificial Insemination (AI).

   - In that way, a sow can produce more than two litters (two farrowings) in a year, which will increase the production of weaner piglets.

Fig. 1 Piglets on day 56 days of age which were weaned at 28 days of age

Fig. 2 Piglets on day 56 days of age which were weaned at 35 days of age

Fig. 3 Piglets on day 77 days of age which were weaned at 28 days of age

Fig. 4 Piglets on day 77 days of age which were weaned at 35 days of age

5. **Critical inputs required:**

- Quality feed and drinking water for piglet and sow
- Hygienic housing with provision of extra source of heating for weaned pigs
- A good floor preferably slated floor furrowing pen and weaner pen with of source of heating for young pigs.

6. **Observation to be recorded:**

- Number of piglets born, weaned and reared /litter
- Lactation length
- Weaning to Estrus Interval of sow
- Body weight of piglets at birth, weaning and at the end of rearing.

7. **Target users/stakeholders:**

Multi Technology Testing Centers (MTTCs)/ KVKs/Commercial piglet producing farmer, who have the facility to rear young pigs.

8. **Precaution (s) with the technology:** Body weight at weaning is more important than age at weaning and it should be more than 5 kg at the time of weaning. If sow milk production is proper, piglets weigh around 5 to 6 kg body weight at 28 days of age, which can be weaned. Cooked feed containing milk powder, Zinc Oxide it essential. Water should be free from germs. Maintenance of microclimatic temperature of 25 to 27ºC in weaner pen is highly essential. Diarrhoea cases should be promptly treated with antidiarrhoeal drugs and electrolytes.

9. **Advantage/ Benefits/ Utility of technology:** The technology enhances production efficiency of sow. From a sow, at least two extra piglets per year can be produced by early weaning, compared to conventional weaning at 56 days of age.

10. **Economics of the technology/ Benefit: Cost Ratio:**

- With this technology, at least two extra piglets per sow per year can be produced, which might give extra profit of Rs.10000.

11. **Technology developed under the project:** First study on early weaning of piglets and rebreeding of sow was conducted in T&D (Tamworth x Desi) pigs, as a part of PhD research work of Dr. Girin Kalita in Assam Agricultural University during 2009-12. With certain modification, the study was repeated in

Large White Yorkshire Pigs, under IRP project entitled *"Effect of early weaning management on performance of Yorkshire sow and Piglets"* funded CAU during the year 2013-14 (Code No. Vety.IRP-III/2013-14).

12. Investigator(s)/inventor(s):

Girin Kalita, Tridib Kumar Rajkhowa, Kalyan Sarma, Rajat Buragohain and Prasanta Saikia: Email:gkgirin@gmail.com; Mobile: 9435839545.

13. Technology publication(s):

Kalita, G., Buragohain, R. and Saikia, P. (2016). Effect of weaning age of litters on the performance of Large White Yorkshire (LWY) sows reared under intensive system of management in Mizoram. *Indian Journal of Veterinary and Animal Sciences Research*, **45**(4):445-449.

Kalita, G., Buragohain, R., Saikia, P., Sarma, K. and Rahman, S.(2015). Effect of Weaning Age on growth Performance and Feed Conversion Efficiency of Large White Yorkshire (LWY) Piglets under Intensive System of Management in Mizoram. *International Journal of Scientific Research in Science and Technology,* **1**(4): 90-94.

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TECHNOLOGY:
NECTAR-AH-38

1. **Name of the technology:** Novel herbal formulation for the treatment of mange in pigs

2. **Source of the technology:** CVSc & AH (CAU, Imphal), Selesih, Aizawl, Mizoram

3. **Year of adoption:** 2014

4. **Description of technology with salient features:**

This invention relates to a process for preparing the composition for the treatment of mange infection in pigs. Mange infection is a contagious disease, caused by mites such as *Sarcopticscabei*, *Psoropticscabei*, and *Demodectic*, which spreads amongst the animals by contact. The disease causes damage to the skin, thereby the economic value of hides and skin is adversely affected. Sometimes, it may spread to human beings, who come in contact with the affected animals.

The available medications have certain limitations like the recurrence of infection on discontinuation of treatment, besides being costly. The treatment for mange usually depends on the administration of allopathic drugs, but these may carry a risk of toxicity to animals and people; thus, finding a nonallopathic treatment for mange remains a great challenge. The formulation was applied in naturally-mange infected pigs. The animals were positive for *Sarcoptic scabei* and *Psoroptic scabei*. Application of the formulation showed complete recovery from infection of these species after 15 days as skin scrapings from treated animals were examined and found to be free from mites.

Process of herbal formulation preparation:

- Fresh leaves of Neem and Lemon were collected and washed gently with tap water until the plant materials looked clean.
- Then the plant materials were allowed to shade dry for 2-3 weeks.
- The dried materials were finally powered with the help of an electric blender.
- Similarly, onion, turmeric, and garlic were also dried for 2-3 weeks and made powder with the help of an electric blender.
- In order of preparation of herbal formulation for the treatment of mange in pigs, neem leaves powder, lemon leaves powder, turmeric powder, onion powder,

and garlic powder was mixed in the ratio of 3:3:2:1:1 (w/w).

- The powder as mentioned above was mixed in olive oil 25:75(w/v) slowly at a temperature between 15 and 20°C with continuous shaking and stirring till a homogeneous mixture is obtained.

- Before trial on the pig, a toxicity trial has been conducted on ice. The mice receiving the topical application of herbal formulation did not show any toxic symptoms and mortality during 72 h of the observation period. Thus, mice tolerated formulation, which indicates that the formulation is safe. The formulation did not affect the locomotor activity, aggregation toxicity, anaphylactic reaction, anticonvulsant and tranquilizing effect, thus, suggesting that it does not affect the nervous system

- The formulation so obtained is to be stored in an airtight container.

Mode of application: The formulation, so obtained, is applied after clipping the hair of affected parts and removing the crust with the brush. The formulation is applied once daily. For mild infection, four applications are sufficient, two applications on consecutive days, and two more applications on alternate days. In heavy infections, the formulation is applied twice daily for 7 consecutive days.

Field trial of **"polyherbal ointment"** showed 99% effective against sarcoptic mange infestation in the pig. It is also useful against any skin infection. It should be applied topically twice daily for 7 days on the affected parts.

5. Critical inputs required:

- Neem leaves
- Turmeric powder
- Garlic Powder.
- Lemon leaves
- Onion Powder

6. **Observation to be recorded:**

- Improvement of clinical score
- Reduce or absent mite count in skin scraping
- Improvement o haemato-biochemical alteration.

7. **Target users/stakeholders:** MTTCs/ KVKs/Farmers

8. **Precaution(s) with the technology:** There is no side effect. Before applying, the affected area should be cleaned with water and dry, then apply the ointment

9. **Advantage/ Benefits/ Utility of technology/product:**

The formulation is effective in the treatment of mange infection in different species of livestock and it is comparatively as efficacious as standard Allopathic treatment and the recurrence of infection is negligible. The preparation of the formulation is technologically and economically viable. The formulation is easy to apply. low cost, easy to prepare, no adverse side effects.

10. **Economics of the technology/ Benefit: Cost Ratio:**

If compare with allopathic medication, the benefit ratio is 1:4.

11. **Technology developed under the project:** "Seroprevalence and therapeutic management of sarcoptic infestation of Pig in Mizoram" funded by Central Agricultural University, Imphal.

12. **Investigator(s)/inventor(s):**

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13. **Technology publication(s):**

Sarma, K., Roychoudhury, P., Das, G., Borthaku, S. K., Kalita, G., Prasad, H. and. Chaudhary, J. K. (2019). Seroprevalence of *Sarcoptes scabiei* var *suis* infestation in swine population and its effect on haemato-biochemical and oxidative stress indices and its management with special reference to herbal ointment. *Indian J. Anim. Res.*, **53**(11): 1489-1496. (DOI: 10.18805/ijar.B-3672).

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TECHNOLOGY:
NECTAR-AH-39

1. **Name of the technology:** Techniques of ejaculation and preservation of liquid semen of *Zovawk* for artificial insemination (AI) in pigs

2. **Source of the technology:** CVSc & AH (CAU, Imphal), Aizawl, Mizoram

3. **Year of adoption/ development:** 2014

4. **Description of technology with salient features:**

   Normal breeding in *Zovawk* breed of pig is done by natural breeding procedure. Studies have been conducted to train the boar for semen collection and preservation of semen. Although boars were found to be very difficult to train yet efforts for mounting on the dummy (wooden and commercial dummy) for semen collection have been done at CVSc & AH. Semen was collected by allowing the boar to mount on live dummy (restrained gilt). The quality of ejaculated semen was found to be similar with other breeds of the species except the volume which is less as the body size of the animal is also small. The semen can be preserved successfully for about 4 days with the extenders like BTS, Androhep, GEPS in liquid state at 17^0C.

Fig. 1 Collection using Wooden Dummy

Fig. 2 Collection using Live Dummy

Fig. 3 Collection by Fist hand method

Fig. 4 Preservation in different media

Fig. 5 Preservation in different containers

Fig. 6 Temperature of Preservation

5. **Critical inputs required:**

- Training of boar for semen collection which is difficult and needs patience.
- Zovawk boar semen may not be readily accepted by the farmers for breeding purpose due to small size of the breed.
- A good laboratory for semen processing.

6. **Observation to be recorded:**

- Quality of ejaculated semen
- Quality of preserved semen
- Fertility of preserved semen.

7. **Target users/stakeholders:** MTTCs/ KVKs/ Pig Farmers

8. **Precaution(s) with the technology:** Strict hygienic measures during the whole process need to be observed.

9. **Advantage/ Benefits/ Utility of technology:** With this technology, at least 4-6 insemination dose can be prepared from single ejaculate whereas single ejaculate is for single insemination in natural service.

10. **Economics of the technology/ Benefit:**

- Numbers of extra piglets can be produced per ejaculate which might give extra profit to the farmers.

11. **Technology developed under the project:** CAU-IRP and MVSc research work

12. **Investigator(s)/inventor(s):**

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13. **Technology publication(s):**

Das, A. K., Lalrintluanga, K., Ahmed, F. A., Ahmed, N., Ali, M. A., Subudhi, P. K. and Deuri, D. (2016). Holding Time Influences Frozen Semen Quality of Mizo Local Boar (Zovawk). *Indian Journal of Animal Reproduction,* **37**(2): 59-60.

Das, A. K., Ahmed, N., Lalrintluanga, K. and Deuri, D. (2016). Effect of different extenders on quality of frozen semen of Mizo local Boar (Zovawk). *International Journal of Agricultural Science and Research,* **6**(3):65-70.

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TECHNOLOGY:
NECTAR-AH-40

1. **Name of the technology:** Homemade herbal feed additive to improve performance of pigs and poultry with total replacement of antibiotics

2. **Source of the technology:** CVSc&AH (CAU, Imphal), Aizawl, Mizoram

3. **Year of adoption/ development:** 2016

4. **Description of technology with salient features:**

   Weaning stress is a major setback for pig farmers throughout the world since the transition from mother's milk to total feed-based piglets' diet results in lowered immunity and susceptibility of the piglets to a host of bacterial and viral infections resulting in substantial reduction in the feed conversion ratio, diarrhoea and post-weaning mortality. **Enhancing the immunity level** of gilts and sows besides that of the piglets, especially the cell mediated immunity and innate immunity; will help in reducing the transmission of pathogens from the sows to the piglets. This has become the need of the hour in the context of PRRS and classical swine fever for which neither any effective vaccine is available on regular basis nor any effective treatment. Likewise, in broiler farming many viral diseases *viz*., newcastle disease, infectious bursal disease etc., bacterial diseases *viz*., colibacillosis, salmonellosis etc. and coccidial diseases cause substantial mortality and economic loss due to poor weight gain. Presently, antibiotics are used as growth promoters/ preventive for secondary bacterial infections during viral disease outbreaks.

   Preparation/ Methodology: A farmer can grow the perennial herb Indian pennywort (*Centella asiatica*) in his garden/terrace land, harvest the leaves/ aerial parts time to time, dry it in shade without exposing the plant material to direct sunlight, grind them using a domestic grinder after drying (within 3 days usually at room temperature), weigh 100 g using a grocery scale and store in sealed polypropylene/polyethylene bags for use over a period of one year by storing at a cool dry and dark place.

   Name of the plant: *Centella asiatica* (Assamese: Manimuni, Bengali**:** Thankuni, Hindi: Brahmamandooki Manipuri: Peruk, Mizo: Lambak, Nepali: Ghod-tapre, Sanskrit: Mandukaparni).

   Product: Shade dried aerial parts/ leaves with stalk harvested between November – March every year, powdered and packaged in sealed polyethylene bags.

   Package size: 100 g; to be mixed in one quintal of pig/ broiler/ Japanese quail/ duckling feed, to be fed for a period of one month to achieve the desired immunity level and as a substitute to antibiotics used as feed supplements/ growth promoters. This can be repeated after one-month gap to keep the immunity level maintained.

Marginal farmers growing pigs on kitchen waste/ backyard poultry farmers can give fresh leaves grown in their garden/ pots @ 30 leaves/ sow, 20 leaves/ grower, 10 leaves/ weaner piglet, 5 leaves/ suckling piglet or village chicken after chopping into small bits.

For suckling piglets creep feed: 200 g per quintal; same dose as a therapeutic in weaner piglet diarrhoea. For sow's feed: 100 g in two quintals.

5. **Critical inputs required:**
   - Enough land for plant bed
   - Seeds/saplings/ whole plant uprooted for transplantation
   - Assured water source during dry season to maintain the perennial herb
   - Domestic mixer/grinder.
   - Polypropylene sachets for 100 g dry powder packaging.

6. **Observation to be recorded:**
   - Growth rate of piglets/broiler chicks given the feed additive compared to the ones not given the additive receiving the same quantity of feed on daily basis.
   - Incidence of diarrhoea, respiratory distress or any other illness in normal course/ disease outbreak.
   - Comparison of antibody titers if feasible, 14 to 21 days post vaccinations.
   - Overall improvement in appearance of piglets/ chickens.

Fig. 1 Plant bed in farmer's backyard grown organically (FYM), perennially, sprinkling water during dry season

Fig. 2 Leaf of the plant to be plucked along with leafstalk

7. **Target users/stakeholders:** Technology is for the farmers and by the farmers. The CAU extension wing/ KVKs can disseminate the technical know how to the end users (pig and poultry farmers)

8. **Precaution (s) with the technology:**
   - The plant bed should be moist always but there should not be water logging submerging any aerial part. Can be grown on the inclined surface in terrace farming in the hilly terrain.
   - The plant requires at least 5-6 h of good sunlight to generate the medicinal metabolites. East/South-east facing terrace is a good option

to have higher medicinal value of the plant.

- Matured dark-green leaves are to be plucked along with leaf stalk for shade drying. Pulling of the leaves can damage the roots and has to be avoided.
- Sun drying destroys the medicinal properties.
- Time for harvest in the North-east India tropical hill climate is from October to May. Best time is November to March.
- Rainy season has the lowest medicinal properties.
- Purple coloured leaves during peak winter, tender/yellowing leaves and insect eaten leaves are to be excluded during collection for shade drying, pulverizing and packaging.

9. **Advantage/ Benefits/ Utility of technology:**

- Homemade (zero input) herbal feed additive for better weight gain and reduced mortality in pigs and chickens due to infectious diseases without using antibiotics facilitating organic meat production.
- Helps in preventing zoonotic disease transmission to farmers and meat consumers by maintaining carrier free stock by strengthening innate immunity in the face of non-availability of vaccines.
- Farmers can participate in the global campaign for fighting anti-microbial resistance by avoiding their use which may not be required due to strengthening of immunity.

10. **Economics of the technology/ Benefit: Cost Ratio:** Zero input cost. The farmer can grow the perennial herb organically using farm yard manure/ vermicompost and sprinkling water keeping the soil moist all the time (to be adopted by transfer of the technical knowhow from the university to the farmers through extension activities)

11. **Technology developed under the project:** Technology developed by validation over more than 3 decades conducting several experiments and controlled clinical trials and use in the face of disease outbreaks besides routine use as feed additive before releasing the technology to CAU, Imphal.

12. **Investigator(s)/inventor(s):**

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13. **Technology publication(s):**

Subudhi, P. K. (2011). Evaluation of *Centella asiatica* extract for delivery and immunoregulation of Newcastle Disease DNA Vaccine *in ovo*. Ph.D. Thesis, submitted to I.V.R.I. Deemed University, Izatnagar.

Subudhi, P. K. (1993). Studies on immunomodulatory effect of *Centella asiatica*, *Phyllanthus niruri*, *Tinospora cordifolia* and *Vigna radiata* in rabbits. MVSc Thesis, submitted to Birsa Agricultural University, Ranchi.

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TECHNOLOGY:
NECTAR-AH-41

1. **Name of the technology/new breed/ new germplasm:** High value Manipuri poultry breed *Kaunayen* (best suited for local environment as sport activity).

2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Manipur

3. **Year of registration:** 2016 (**Accession No:** INDIA _chicken _1200 _kaunayen _12017)

4. **Description of new breed with salient fatures:**

a. Area of adaptation

- Valley districts of Manipur state.
- Also found distributed in scattered area of other hill districts of the state.

b. Parentage

- Before this study, no information on this chicken was available in the scientific literature.
- As a part of the initiatives of ICAR-NBAGR, Karnal for identification, evaluation, characterization of non-descript livestock and poultry population, the Department of Animal Sciences, College of Agriculture, CAU, Imphal in technical collaboration with NBAGR, Karnal surveyed for the availability of non-descript uniform population and in the process, this indigenous chicken has been identified in its breeding tract. In order to arrive whether the population is qualified to become a recognized breed, CAU has taken up extensive evaluation work to study its morphometric, performance, and genetic characteristics and with the generated data, the CAU-NBAGR team could apply for registration of the breed at the national level. Studies on suitable managemental practices to be followed by the bird owner was also carried out as a part of the work, which has enabled documentation of the scientific strategies for housing, feeding, breeding and disease management of this chicken, in addition to the documentation of its economic potential. The application of this new technique will be useful in generating increased income from rearing Kaunayen chicken by the unemployed and interested people.

c. Economic trait

- Kaunayen birds are mainly prized for their 'martial qualities'.
- Adaptable in local climate and poor feeding environment
- Highly resistance to various local diseases
- Highly alert, has more fighting stamina for longer duration fights compared to any other well-known fighting breeds and as such lots of demand for game purposes.

d. Morphology

- Kaunayen birds have elongated body with long neck and long legs.
- The predominant plumage color is black followed by brown (or red) with patches of white, black, brown or golden feathers on neck, back and wings especially in males.
- Hens are generally black, grey, blackish grey or whitish grey with few brown feathers on neck, breast and wings.
- Comb is red in colour, mainly pea type while skin is white or pinkish white.

Fig. 1 *Kaunayen* cock

Fig. 2 *Kaunayen* Hen and chick

- Neck, breast and thighs are generally bare, hard and rose red colored in fighting cocks.
- Wattles are absent while spur is long and sharp in cocks. Shank is yellow, sometimes grayish in color.

e. Utility

- Kaunayen birds are used mainly for game purpose (fighting).
- There is a high demand for fighter cocks. Breeders rear these birds for commercial purpose and sell chicks/adults to earn money.
- Fighter cocks are also traded with breeder from neighboring states and countries.
- Eggs are mostly set for hatching and consumed only when the mating is by unwanted males.

f. Housing management

- Kaunayen birds can be reared in the backyard free range system. Some breeders rear the birds especially cocks under intensive system.
- Cocks, being more ferocious, can be caged individually in bamboo cages. These cages may be placed in shade to protect the birds from Sun.
- Hens and chicks can be kept mostly in the open. The birds may be conveniently housed during night in single storied enclosures made from wood or bamboo and wired mesh.

g. Feeding management

- Scavenging with supplementation of kitchen waste, and local feeds like chamang (rice used for brewing local wine), maize, gram, broken rice, vegetables, etc. may be practiced as a most common feeding system. Commercial feed is not compulsory.
- Birds may be fed two times a day – morning and evening. Free ranging can be practiced in groups to avoid fighting among birds.
- Fighting birds may be fed with dry fish, beef, eggs, banana, almond, raisins, butter, etc.

h. Breeding management

- The main breeding strategies are to hatch by selecting eggs from a female born from mating of proven sire and dam.
- Old cocks, which are unable to fight but otherwise are good and healthy, can be used for breeding after cutting the spur.
- Relatively short shank and long thigh, broad and round rib cage, long body, more bony than fatty type, erect standing posture with head held high are some of the features believed to deliver a good kick during fight, must be considered for selection of cocks for fighting.

i. Disease management

- Mortality is very little, almost nil.
- Mosquito bite is a common problem besides cold and cough. Both allopathic and herbal treatments may be given for cure. Good night repellant and burning of egg trays or dry lemon peel may be practiced to prevent from mosquito bite. Adhatodavasica leaves either boiled in water (4-5 drops) or fried and mixed with sugar can be given to birds for treatment of respiratory diseases like cough, cold, etc.
- However, no vaccination is administered against any disease.

j. Performance

- Body weight of an adult cock ranged from 2.4 to 3.8 kg with an average of 3.01±0.06 kg and that of an adult hen from 1 to 2.9 kg with an average of 2.32±0.09 kg.
- Kaunayen hen lays about 35 eggs per annum. Eggs are medium in size with an average of 42.43±0.07g. Shell colour is brown. After laying period, the hen becomes broody.
- Normally 12-15 eggs can be set at one time and the hen incubates the eggs for 20-21 days. Hatchability on total egg basis varies from 65-100% with an average of about 80%.

k. Disadvantages

- Poor layer

l. Unit cost

- A pair of chicks (male and female) costs around Rs 500. Price of a month-old cockerel is around Rs. 1000/- and 8-month old cock about Rs. 2,000 - 3,000. The price of a fighter cock ranges from Rs.10,000 to Rs. 20,000 depending upon fighting qualities.

5. Target users/stakeholders: MTTCs/KVKs/Farmers/Interested people

6. Advantage/ Benefits/ Utility new breed:

- There is lot of demand for good male and female germplasm of Kaunayen breed for developing good fighter cock for game purposes. So, breeder can earn good income from the sale of purebred chick, cockerel and cocks.
- Characterization and registration of the breed has not only prevented the dilution of the breed, but has certainly helped in producing the true potential of the breed with higher performance through further selective breeding.

7. Economics of the technology/new breed/new germplasm:

- Ten proven birds can earn a minimum of Rs. 60,000 per annum @ Rs. 6,000 (Rs. 250 x 24 chicks) by one bird producing 24 chicks in a year.
- After subtracting an investment of Rs.10,000 for purchase of chick and other minor expenditure, the approximate net income from rearing 10 birds will be

Rs. 50,000 per annum. The profit will be increased as the size of the farming increases.

8. **Technology developed under the project:**

"Kaunayen Chicken: A new indigenous germplasm from Manipur", a research project in collaboration with the ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana.

9. **Investigator(s)/inventor(s):** Th. Ranadhir Singh, P. K. Vij and M. S. Tantia**:** Email: rdthiyam@yahoo.co.in

10. **Technology publication(s):**

Vij, P. K., Tantia, M. S. and Singh, Th Ranadhir (2016).Kaunayen chicken – a new indigenous germplasm from Manipur. *Indian Journal of Animal Sciences,* **86** (9): 1085–1087.

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TECHNOLOGY:
NECTAR-AH-42

1. **Name of the technology:** Process for preparing a novel herbal formulation for the treatment of piglet diarrhoea
2. **Source of the technology:** CVSc&AH (CAU, Imphal), Aizawl, Mizoram
3. **Year of adoption/ development:** 2017
4. **Description of technology with salient features:**

Therapy of diarrhoea can be done by anti-secretory drugs like as bencetimide and loperamide alone or incombination with antibacterial agents. As a supportive therapy of diarrhoea electrolyte replacement through orally to prevent fluid loss can also be given. Indiscriminate antibiotic treatment often associated with generation of resistant bacterium is big management problem using synthetic drugs in the treatment of piglet diarrhoea. Loperamide, an anti-secretory drug has unwanted side effects like abdominal cramp,constipation, drowsiness, dizziness. Antibiotics like tetracycline, chloramphenicol, aminoglycoside, fluoroquinolones produce hepato toxicity, bone marrow depression,nephrotoxicity and gastro-intestinal (G.I) disorders, respectively as side effects of the treatment with these drugs.

In view of low residual contamination, low environmental pollution of natural raw materials, a increasing number of studies are focusing on phylogenic products that comprise a wild variety of herbs, spices, and essential oils.

Herbal therapy is one of the alternatives to mitigate the problems of using synthetic drugs, as there is less chance of toxicity, easy availability and also being economical. Indian subcontinent is full of plant species having medicinal values, so people can exploit these for treatment of diarrhoea., scientific name of Bale (*Aegle marmelos*) is an important medicinal plant found all over India. Leaves, fruits, stem, bark and roots of *Aegle marmelos* have been used in ethno-medicine as astringent, antidiarrhoeal, antidysentric, demulcent, antimicrobial, and anti-inflammatory activities

Extracts of methanolic unripe fruit-pulp extract of *Aegle marmelos* were evaluated at doses of 15 mg kg^{-1} , 30 mg kg^{-1}, 120 mg kg^{-1} and 1600 mg kg^{-1} in SD rats for anti diarrhoeal effect in castor oil induced diarrhoea. For toxicity effect, 5000 mg per kg of methanolic extract of *Aegle marmelos* was administered orally to three rats at first with 0.02% tween 80 vehicles and observed for any abnormal condition up to 14 days. The study revealed that the dose of 30 mg kg^{-1} BW and 1600 mg kg^{-1} BW of methanolic extract of *A. marmelos* showed same treatment response with Loperamide against castor oil induced diarrhoea in rats. Study was carried out to determine the anti-diarrhoeal effect of the unripe methanolic fruit-pulp extract of *Aegle marmelos* against clinical cases of piglet diarrhoea. The therapeutic trial of different doses of methanolic fruit pulp extract of *A. marmelos* against clinical cases of piglet diarrhoea revealed that the treatment with Loperamide in combination with methanolic fruit-pulp extract of *Aegle marmelos* @ 274 mg kg^{-1} BW was the best treatment followed by

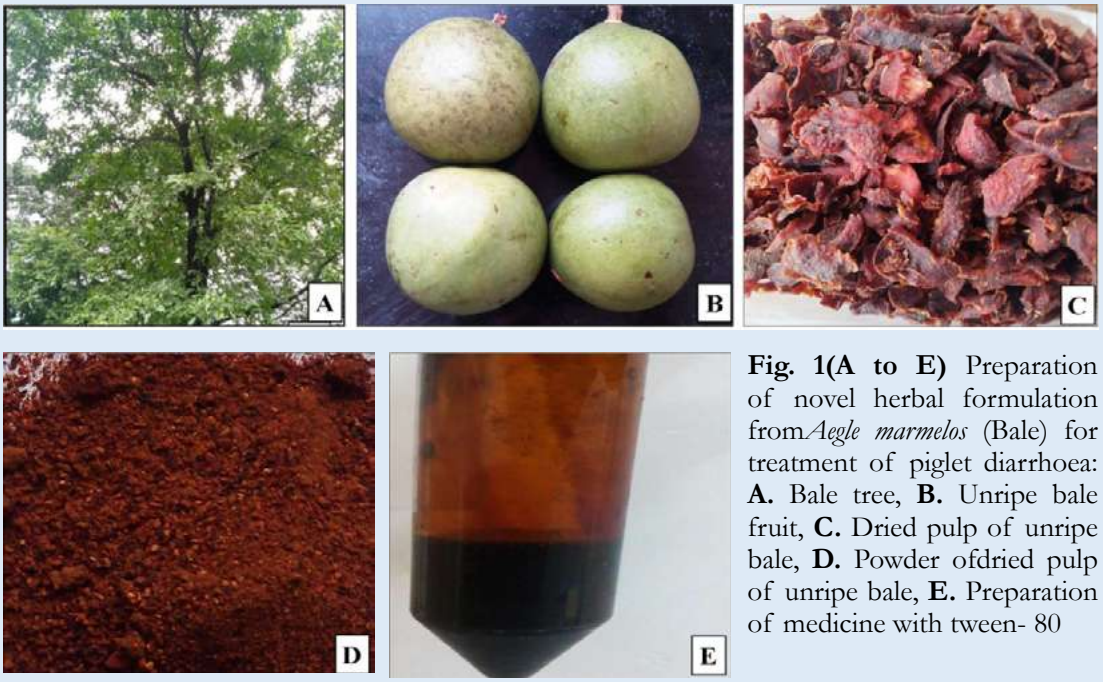

Fig. 1(A to E) Preparation of novel herbal formulation from*Aegle marmelos* (Bale) for treatment of piglet diarrhoea: **A.** Bale tree, **B.** Unripe bale fruit, **C.** Dried pulp of unripe bale, **D.** Powder ofdried pulp of unripe bale, **E.** Preparation of medicine with tween- 80

Fig. 2(A to C) Treatment of piglet diarrhoea: **A.** Diarrhoic piglet before medication, **B.** Oral medication ofdiarrhoea affected piglet, **C.** Recovered piglet after medication

treatment with methanolic fruit-pulp extract of *Aegle marmelos* @ 274 mg kg^{-1} BW alone in comparison with other treatment groups. A process for preparing an herbal formulation for the treatment of piglet diarrhoea is given below:

- The active compound of *Aegle marmelos* was extracted by methanol, by using a Soxhlet extractor in 36 °C for 12 h. Then recovery of solvent was done in Soxhlet extractor in 170 °C for 35 minutes. Resulting liquid extract was filtered using Whatman filter paper (No.1) and then concentrated in a vacuum and dried at 40 °C for methanol elimination and to obtain a dark-brown residue.
- The extract was dissolved in water with the help of 0.02% tween 80 and applied in clinical trial.

Mode of application: Unripe methanolic fruit-pulp extract of *Aegle marmelos* @ 250 mg kg^{-1} body weight orally twice daily for 5 days.

Utility of the formulation: The formulation is effective in the treatment of diarrhoea in different species of livestock and it is comparatively as efficacious as standard therapy i.e. loperamide and the recurrence of infection is negligible. The preparation of the formulation is technologically and economically viable. The formulation is easy to apply.

5. **Critical inputs required:**

- Unripe bale (*A. marmelos*)

6. **Observation to be recorded:**

- Improvement of clinical score
- Reduce or absent diarrhoea
- Improvement of haemato-biochemical alteration

7. **Target users/stakeholders:** Pig farmers

8. **Precaution (s) with the technology:**

   There is no any side effect. Along with the herbal medicine, electrolyte solution should be given.

9. **Advantage/ Benefits/ Utility of technology:**

   Low cost, easy to prepare, no any adverse effect

10. **Economics of the technology/ Benefit: Cost Ratio:** If compare with allopathic medication, the benefit ratio is 1:4

11. **Technology developed under the project:**

    MVSc student's research project entitled "Therapeutic evaluation of methanolic fruit pulp extract of *Aegle marmelos* against Piglet Diarrhoea"and IRP project funded by Central Agricultural University, Imphal.

12. **Investigator(s)/inventor(s):**

    Santanu Gorai, Kalyan Sarma, Y. Damodar Singh and Gunjan Das: Email: kalyan_srm@rediffmail.com; Mobile: 8006400472.

13. **Technology publication(s):**

    Ghorai, S., Sarma, K., Roychoudhury, P., Das, G., Singh, D., Kalita, G. Chaudhary, J., Arya, R. S. (2018). Anti-Diarrhoeal Activity and Toxicity Trial of Methanolic Fruit-Pulp Extract of *Aegle marmelos* (L.) Correa in Sprague-Dawle Rats. *International Journal of Livestock Research*, **8**(9): 326-337.

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TECHNOLOGY:
NECTAR-AH-43

1. **Name of the technology:** Adoptation of local pig of Mizoram "*Zovawk*" as recognized breed of India
2. **Source of the technology:** CVSc&AH (CAU, Imphal), Aizawl, Mizoram
3. **Year of adoption/ development:** 2018
4. **Description of technology with salient features:**

   The local pig '*Zovawk*' has been registered with ICAR-NBAGR, Karnal (Accession No. INDIA-PIG-2700-ZOVAWK-09007). The Mizo Local pigs '*Zovawk*' ('Zo' means Mizo and 'vawk' means pig), are associated with Mizo people since time immemorial. The exact origin is not known; however, it is believed to have originated from a wild pig native to this countryside. It is assumed that the Mizo ancestors were rearing these pigs even when they were occupying Kabaw valley in Myanmar and must have brought with them during their migration to India. The pigs were the main source of meat (Protein) and oil. In fact, pork was the meat of Choice to Mizo people.

Physical characteristics:

- The predominant skin colour is black with a distinct white spot on the forehead (star), white patches on belly (sometimes) and white boot.
- They have a compact body with smooth skin, convex head profile among all age groups with erect ears oriented upwards and a short and cylindrical snout.
- Tusk are present only in animals of above 18 months of age. Sows possessed 5 to 7 pairs of teats.
- The adult animals possess a pot-belly shape with droopy back posture.
- They are social animals and have good adaptability to hilly areas.

Production performance:

Traits/Characters	Average	Range
Individual weight at birth (kg)	0.540	0.470 - 0.610
Individual weight at weaning (kg)	3.12	2.00 - 4.25
Litter size at birth	7.03	2 – 12
Litter size at weaning	5.2	3 – 8
Adult body weight (kg)		
a. Male	54	45 - 63
b. Female	58.5	46.5 - 70.5
Age at first mating (days)		
c. Male	240	220 - 300
d. Female	199	180 – 235
Body weight at first farrowing (kg)	40.45	33.5 - 47.4
Age at first furrowing (days)	314.9	294 – 350
Dressing %	69	64 – 74
FCR	5.14	4.15 - 5.64

5. **Critical inputs required:**

- Pigs, improve feeding and management.

6. **Observation to be recorded:**

- Breed characteristics, growth performance, litter size at birth and weaning, adult body weight.

5. **Target users / stakeholders:** Farmers, KVKs, SHGs and Entrepreneurs

6. **Precaution (s) with the technology:** Care has to be taken that it is conform to the breed characteristics

7. **Advantage/ Benefits/ Utility of technology:** More adaptable to local environmental condition.

8. **Economics of the technology/ Benefit: Cost Ratio:** The meat of the Zovawk is local delicacy and preferred by the local populace. Socio-economic upliftment of rural pig farmers**.** B: C ratio is 1.25.

9. **Technology developed under the project:** ICAR-All India Coordinated Project on Pig, CVSc&AH**,** (CAU, Imphal), Selesih, Aizawl, Mizoram.

10. **Investigator(s)/inventor(s):**

N. S. Singh, A. K. Samanta, T. C. Tolenkhomba, K. Lalrintluanga and J. B. Rajesh**:** Email: nssagb@rediffmail.com; Mobile: 9436354620.

11. **Technology publication(s):**

Tolenkhomba, T. C., Saikia, P., Hmar, L., Zuali, T., Prava, M. and Singh, N. S. (2013) Principal component analysis of body measurements in Mizo local pigs. *Indian Journal* of *Veterinary Research*, **22**(1): 26-31.

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TECHNOLOGY:
NECTAR-AH-44

1. **Name of the technology:** Utilization of palm oil sludge (POS) as pig feed
2. **Source of the technology:** CVSc&AH (CAU, Imphal), Aizawl, Mizoram
3. **Year of adoption/ development:** 2018
4. **Description of technology with salient features:**

   Palm oil sludge (POS) is an effluent (POME) in the palm oil processing unit whichis the material that remains after decanting the palm oil mill. It is a good source of energy and contains substantial amount of crude protein. High cost of feed is the limiting factor for pig production. Therefore, POS can be the alternative for those costly feed ingredients such as maize to optimize pig production. POS which is available in wet form should be sprayed with 1% propionic acid before sun drying and later the dried POS is grounded to 1 mm size before incorporating in the pig's diet. POS can be fed upto 30% replacement of maize in the diet of growing- finishing pigs without any adverse affect on the growth performance, hemato-biochemical parameter and carcass triats. Economically, incorporation of POS upto 30% level replacing maize was found to be cost effective.

Fig. 1 Fresh palm oil sludge

Fig. 2 Spraying of propionic acid

Fig. 3 Grounded dried POS

5. **Critical inputs required:**
   - Palm oil sludge and other conventional feed ingredients.
6. **Observation to be recorded:**
   - Body weight changes
   - Feed conversion efficiency
   - Nutrient digestibility
   - Carcass traits

7. **Target users/ stakeholders:** Farmers, MTTCs, KVKs, SHGs and Entrepreneurs

8. **Precaution(s) with the technology:** Proper sun drying of palm oil sludge to prevent the growth of fungus

9. **Advantage/ Benefits/ Utility of technology:** Livestocks rearer in places where palm oil processing unit exist can utilize the byproduct *i.e.* palm oil sludge which is cheap source of energy and found in abundance.

10. **Economics of the technology/ Benefit: Cost Ratio:** Pig farmers will get more profit by feeding pig with POS based diet

11. **Technology developed under the project:** Ph. D thesis work entitled "Effect of feeding palm oil (*Elaeis guineensis*) sludge as a partial replacement of mize on the performance of growing-finishing pigs", submitted to CAU during 2018. (CAU/05-V/15(PhD).

12. **Investigator(s)/inventor(s):**

Temjennungsang Jamir, A. K. Samanta, B. K. Das, Girin Kalita and M. Ayub Ali: Email: aksamanta73@gmail.com; Mobile: 9862335446.

13. **Technology publication(s):**

Temjennungsang and Samanta. A. K. (2019). Effect of partial replacement of maize with palm oil sludge on growth performance, nutrient digestibility and blood profiles of finishing pigs. *Animal Nutrition and Feed Technology,* **19**: 229-240.

Samanta, A. K., Jamir, T., Singh, N. S., Zosangpui and Lalliankimi, H. (2019). Effect of feeding palm oil (*Elaeis guineensis*) sludge as partial replacement of maize on the performance of growing crossbred (Large White Yorkshire x Zovawk) pigs. *International Journal of Livestock Research*, **9**(1): 336-342.

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TECHNOLOGY:
NECTAR-AH-45

1. **Name of the technology:** Rapid detection of piglet diarrhea associated with *Escherichia coli* infection using polymerase spiral reaction (PSR) assay
2. **Source of the technology:** CVSc&AH (CAU, Imphal), Aizawl, Mizoram
3. **Year of adoption/ development:** 2019
4. **Description of technology with salient features:**

Piglet diarrhea caused by enteropathogenic *E. coli* (EPEC) is one of the major disease conditions lead to the high mortality of piglets. The existing techniques for diagnosis are cumbersome, time consuming, costly and difficult to perform at field level.

The present technique developed in the Department of Veterinary Microbiology, CVSc&AH, CAU, Aizawl, Mizoram is easy to perform, cost effective, does not need any sophisticated equipments and can be performed at field level.

Under this technique, a single pair of oligonucleotides primers is being used and the entire technique is performed under isothermal condition and the result is visible under naked eye within one hour. The sensitivity and specificity of the technique are as per the existing technique, *viz*., real time PCR and better than the conventional PCR.

Standardization and application of PSR assay:

For PSR assay, specific PSR primers (1.6 µM each) designed for *eaeA* gene should be used (Table-1). The assay should be performed in 25 µl reaction mixtures containing 2.5 µl of 10x ThermoPol reaction buffer (New England Biolabs), 6 mM $MgSO_4$, 0.8 M betaine (Sigma-Aldrich), 1.4 mMdNTP, 8 U of *Bst* polymerase, large fragment (New England Biolabs) and 5 µl of bacterial lysate as template. The reaction should be carried out at 65°C for 1 hour. After 1-hour incubation, the PSR product should be mixed with 1 µl of 1:10 diluted SYBR Green I and 10,000 x DMSO concentrated (Invitrogen). The positive control (*E. coli* H-01/Sel/2013) and positive samples will display colour change from orange to green, while the negative control (*E. coli* H-25/Sel/2013) will remain orange.

Table 1 Oligonucleotide primers used for detection of *eaeA* gene by PSR assay

Primer	Sequence	Position
eaeA/PSR-F	5'- *acgattcgtacatagaagtatag*-GACCCGGCACAAGCATAAGC -3'	120, 223-120, 242
eaeA/PSR-R	5'-*gatatgaagatacatgcttagca*-CCACCTGCAGCAACAAGAGG -3'	120, 587-120, 606

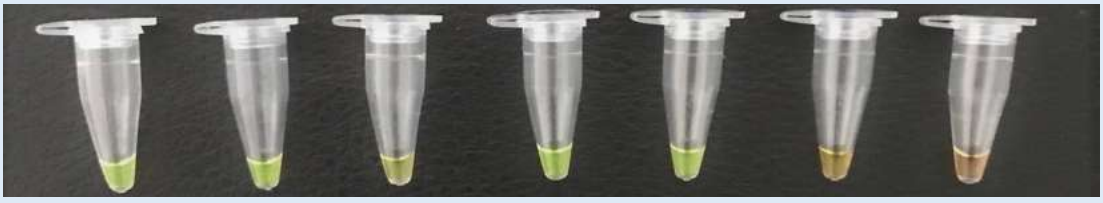

Fig. 1 PSR result visible under naked eyes for detection of *eaeA* gene of *E. coli* isolated from diarrhoeic piglets

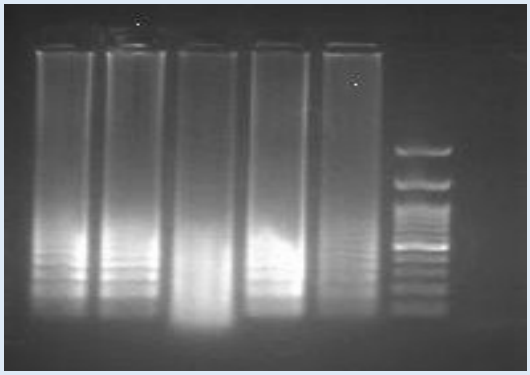

Fig. 2 Agarose gel electrophoresis of PSR products for detection of *eaeA* gene of *E. coli* isolated from diarrhoeic piglets

Critical inputs required:

- Routine laboratory set up for isolation of bacteria from clinical specimens.
- PSR primers
- Extraction of bacterial DNA
- PSR associated reagents and plastic wares

5. **Observation to be recorded:**

   Typical PSR amplicons deposited at the bottom of the tube

6. **Target users/stakeholders:** Routine disease diagnosis laboratory of state Govt.

7. **Precaution (s) with the technology:** Careful isolation and identification of bacteria and it is DNA.

8. **Advantage/ Benefits/ Utility of technology:** The present technique is cost effective, less time consuming, applicable at the field level, highly specific and sensitive over the existing techniques for the same target.

9. **Economics of the technology/ Benefit: Cost Ratio:**

   The present technique may provide the diagnosis within a maximum cost of Rs. 200 only.

10. **Technology developed under the project:** The technology is developed under the DBT funded project entitled "Advanced Animal Diseases and Diagnosis Consortium (ADMaC)".

11. **Investigators/ inventors:**

    T. K. Dutta, Belinda L. Vangchhia, P. Roychoudhury, Rebecca L. Ralte, P. K. Subudhi: Email: tapandutta@rediffmail.com, Mobile: 9862335294.

12. **Technology publication:**

    Dutta, T. K., Vangchhia, B. L., Roychoudhury, P., Ralte, R. L. and Subudhi, P. K. (2019). Rapid visual detection of diarrhoea-associated *eaeA* gene using polymerase spiral reaction (PSR) from clinical samples. *Indian Journal of Comparative Microbiology, Immunology and Infectious Diseases*, **40**(2): 90-94.

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Chapter - 5

AQUACULTURE (AC) 18 technologies

TECHNOLOGY:
NECTAR-AC-46

1. **Name of the technology:** Run-off water harvesting technology for upland fish-based farming system
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of adoption/development/ publication:** 2012
4. **Description of technology with salient features:**
   - This technology in brief includes construction of a series of different size of ponds in the undulated topography of hill region such as valley, hill slopes, depression and gullies for harnessing runoff water.
   - These ponds are to be in descending order i.e. small, medium and big with the decreasing slopes.
   - Ponds are to be constructed in relation to the gradation of hill slopes without disturbing the natural contour.
   - The smaller ponds at the top of slope act as a recharging pond (RP) besides nursery ponds which are seasonal.
   - The medium sized ponds at the lower elevation of a particular hill slope may act as harnessing of seepage water and rearing ponds for fish fingerlings where water retains more than six months after monsoon is over.
   - The biggest pond at the lowest elevation of slope used for total harvesting of seepage water as well as production/ grow out pond, which are generally perennial in nature for rearing table fish.
   - The excessive runoff water has to be channelized through vegetative channels around the fish farm in such a way that there should not be any excessive erosion of the soil and overflow of the ponds.
   - This can be achieved only through the participatory efforts of the local people for which public awareness is necessary, particularly where the land holding of individual farmer is less and there is a lot of common land available to be utilized by the local community.

The efficacy of this technology has been validated through a PhD research work under aquaculture stream as follows. However, the technology is also very useful in farming system, integrating horticulture, agriculture, animal husbandry with fish farming which need to be validated in different locations. The whole system can be graded into different tiers and the technology for each tier is given below:

✓ **1st Tier System**: High elevation in upland location are used for construction of nursery ponds for rearing spawn to fry of major carps like Rohu (*Labeo rohita*). The size of the water harvesting structure with proper drainage of inlet and outlet may be 100 m^2 to 500 m^2 with an average depth of 1 m. The source of water comprises mainly the runoff rain water during monsoon. The upland soil of NE regions is generally sandy and acidic having poor water retention capacity. To keep pond water (>60%) for at least 6 months, the pond may be lined with synthetic lining (250 µm LDPE black/blue agri-film)with

5-7 cm soil base for plankton proliferation during pre-monsoon period.

- **Duration of culture:** 15 days. Three crops may be taken up during monsoon season.
- **Pond Preparation:** Should be taken up one month before onset of monsoon (April-May), physicochemical properties of pond soil (pH and texture) to be determined. If liming is required, dewatering of the water body is mandatory before application of lime.
- **Cleaning of aquatic weed** may be carried out by manual labour, if required.
- **Eradication of predatory and weed fishes**: Eradication of unwanted organisms may be carried out with application of bleaching powder @ 250-300 kg ha^{-1} followed by netting. Up to 15 days, further activities in the pond may be ceased.
- **Liming:** To mitigate the high levels of acidity in the soil (pH 5.0-6.5), a dose of quick lime @ 260-300 kg ha^{-1} and 25% of actual dose initially based on the soil pH to be applied.
- **Source of water into the ponds:** Preferably rain water from catchment area drainage; Water is allowed up to 50 cm initially followed by maximum depth of 1 meter
- **Doses of organic manure:** Raw Cow Dung (RCD) @ 7,000-10,000 kg ha^{-1} or Poultry manure @ 5,000 kg ha^{-1}, 50% actual dose initially to be applied seven days after application of lime in the pond. The organic manure in water in turn will produce plankton, used as natural food of spawn converting water colour greenish.
- **Eradication of aquatic insects:** Apply/ spray kerosene oil @ 100 l ha^{-1} during sunny day prior to one day before stocking of spawn and followed by repeated netting.
- **Stocking density of spawn:** Induced bred 4-6 days old spawn @10-12.5 lakh ha^{-1} should be stocked after proper acclimatization during early in the morning.
- **Source of spawn:** Either from own hatchery production or procured from reliable sources for quality assurance.
- **Supplementary feed:** Mustard oil cake (MOC)/groundnut oil cake (GOC) and Rice Bran (RB) in 1:1 ratio (CP 18-22%) @ 2-8 times of biomass daily preferably 2 times by broadcasting once in the morning and rest in afternoon from the 2nd day of stocking. Feeding to be stopped one day prior to harvesting. Approximately, 700 kg ha^{-1} supplementary feed will be required for each crop.
- **Water quality:** Monitored weekly specially pH (6.5-7.5), CO_2 (0-3 mg l^{-1}) and total alkalinity (>50 mg l^{-1})
- **Sampling:** First seven days no netting, after one-week sampling should be done with fine mesh net.

Fig. 1 Land before intervention

Fig. 2 Layout of upland run-off water harvesting technology

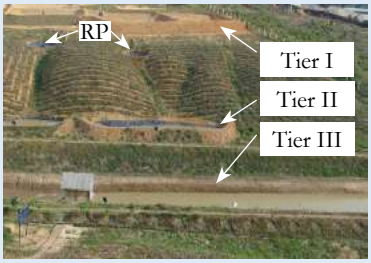

Fig. 3 Design of upland run-off water harvesting technology for fish- based farming system with pineapple as horti- crops (RP= Recharging pond)

Fig. 4 Construction of water harvesting structure in upper elevation

Fig. 5 Pond with synthetic lining with rain water ready for farming of carps

Fig. 6 Synthetic lining of nursery pond in elevated area for seed production

Fig. 7 Synthetic lining-based nursery pond ready for rearing of carp seed with drainage system

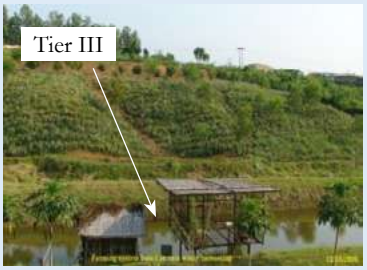

Fig. 8 Tire III earthen pond used for grow out practices

Fig. 9 Series of Ponds at Tier III in the lower elevation for grow out fish culture

Fig. 10 Harvesting of carp fingerlings

Fig. 11 Harvesting of marketable fishes from upland ponds

- **Growth monitoring:** Monitored weekly through sample netting to get uniform growth of spawn.
- **Periodical manuring:** As and when required with split doses in semi liquid form preferably 3-5 days interval. Pond water needs to be maintained to look light green in colour.
- **Harvesting of fry:** On 15th day use fine meshed fry drag net early in the morning and kept for acclimatization.
- **Expected size of fry and yield:** 20-30mm; 30-50% survival of stocked spawn.

✓ **2nd Tier System**: Medium elevation ponds are used for rearing fry to fingerlings of Major carps like Rohu (*Labeo rohita*) and common carp (*Cyprinus carpio)*:

- The size of the water harvesting structure with proper inlet and outlet should be 200 m^2 to 1000 m^2 with an average depth of 1 meter (maximum depth 1.5 m). The source of water stored into the ponds would be rain water of catchment area or

excess water from higher elevation ponds through drainage system. Being sandy-acidic upland lateritic soil of NE region having poor water retention capacity and to keep pond water (>60%) for at least 6 months, the pond may be lined with synthetic lining (250 µm LDPE black/ blue agri-film) with 5-7 cm soil base for plankton proliferation during pre-monsoon period

- **Duration of culture:** 45 days. Two crops may be taken up during a monsoon season
- **Pond Preparation:** Should be taken up one month before onset of monsoon (April-May), physicochemical parameters of pond soil (pH and texture) to be determined. Cleaning and eradication of aquatic weeds by manual labour may be carried out if required. Dewatering of the water body may be carried out before application of lime.
- **Source of water stocked into the ponds:** Preferably rain water; water is allowed up to 50 cm initially followed by maximum depth of 1.5 m.
- **Eradication of predatory and weed fishes:** Eradication of unwanted organisms may be carried out with application of bleaching powder @ 250-300 kg ha^{-1} followed by netting and till next 15 days further activities in the pond may be ceased.
- **Application of lime:** To mitigate the high levels of acidity in the soil (pH 5.0-6.5), quick lime (CaO) is applied: recommended dose is 260- 300 kg $ha^{-1}$and 25% of actual dose initially based on the soil pH.
- **Doses of organic manure**: Raw Cow Dung (RCD) @ 10,000-15,000 kg ha^{-1} or Poultry manure @ 5,000 kg ha^{-1}, 30 % actual dose initially to be applied seven days after application of lime in the pond. The organic manure in water in turn will produce plankton, used as natural food of fry turning water colour greenish.
- **Stocking density:** Stocking density of carp fry (20-30 mm) @ 1-3 lakh ha^{-1}. Should be stocked after proper acclimatization early in the morning.
- **Source of Fry:** From the harvesting of upper altitude nursery ponds used for spawn to fry rearing
- **Supplementary feed:** Mustard oil cake (MOC) and rice bran (R.B.) in 1:1 ratio @ 3-8% of biomass daily preferably 2 times by broadcasting once in the morning and rest in afternoon from the 2nd day of stocking. No feeding one day prior to harvesting. Total feed requirement would be approximately 2,500 kg ha^{-1}.
- **Water quality:** Monitoring weekly specially pH (6.5-7.5), CO_2 (0-3 mg l^{-1}) and total alkalinity (> 50 mg l^{-1})
- **Sampling:** After one week with fry drag net. First seven days no netting
- **Growth monitoring:** Monitoring weekly basis through sampling. Should show uniform growth of spawn.
- **Periodical manuring:** As and when required in split doses in semi liquid form. Mustard Oil Cake @ 700 kg ha^{-1} may be applied in split weekly dose after decomposing for 2-3 days in semi liquid form based on the plankton availability, colour as well as odour of water. Light green colour of water is preferable.
- **Harvesting of fry:** on 40-45th day by fry drag netting. Expected size of fry: 50-100 mm
- **Yield:** 50-70% of stocked rohu fry whereas 60-80% in common carp fry.

✓ **3rd Tier System**: Grow-out ponds in the lowest elevation/valley are used for grow-out practice of IMC (Indian Major carps) and exotic carps

- The size of the water harvesting structure with proper inlet and outlet should be 1,000 m^2 to 10,000 m^2 with an average depth of 2 m (maximum depth 2.5 m).

The source of water stocked into the ponds would be mostly from rain water harvesting and also the excess water from upper elevated ponds. Pond soil should be provided with organic substances to reduce the seepage.

- Being sandy-acidic nature of soil of NE region, to maintain water during dry season, average depth of 1.5 m of water (>60% retention), pond may be lined with synthetic lining (250 µm LDPE black/ blue agri-film) with 5-7 am soil base for plankton proliferation when constructed in high elevation. In low elevated tank ground water as well as controlled rain water may be source of water without synthetic lining
- **Cultivation period:** 3-12 months (upper elevated pond 3-6 months). One to two crops may be taken up.
- **Eradication of aquatic plants** may be carried out by manual labour during March-April months after proper reclamation and repairing of pond dyke and body, if required
- **Eradication of predatory and weed fishes:** Eradication of unwanted organisms/weed-carnivore fishes may be carried out with application of bleaching powder with a recommended dose of @ 250-300 kg ha^{-1} followed by netting and next till 15-20 days further activities in the pond may be ceased.
- **Liming**: To correct the high levels of acidity in the pond soil (pH 5.0-6.5), application of quick lime (CaO) is recommended and dose is 300 kg ha^{-1} and 25% of actual dose initially based on the soil pH. Rest of the lime may be applied in 3 equal quarterly doses.
- **Doses of organic manure**: Raw cow dung (RCD) @ 10,000-15,000 kg ha^{-1} or poultry manure @ 5,000 kg ha^{-1}, 30% actual dose initially to be applied seven days after application of lime in the pond. The organic manure in water in turn will produce plankton, used as natural food of fishes turning water colour greenish. Rest of the organic manure may be applied fortnightly in semi-decomposed form.
- **Stocking density:** Stocking density of carp fingerlings (50-80 mm) @ 10,000 no. ha^{-1} (Catla, Rohu, Mrigal, Common carp in 1:2:1:1 ratio) to be stocked during May-June once the pond water colour is greenish. Should be stocked only after proper acclimatization in the morning hours.
- **Source of fingerlings:** Own source harvested from upper elevated rearing ponds.
- **Supplementary feed:** Mustard oil cake (MOC) and rice bran (R.B.) in 1:1 ratio or pelleted feed (22-25% crude protein) @ 3-5 % of biomass daily preferably 2 times by broadcasting once in the morning and rest in afternoon from the 2nd day of stocking. Total feed requirement would be approximately 6000 kg ha^{-1}.
- **Water quality:** Monitoring fortnightly basis specially pH (6.5-7.5), CO_2 (0-3 mg l^{-1}) and total alkalinity (> 50 mg l^{-1}).
- **Management measures:** Checking of growth and survival of fingerlings every month using fingerling drag net. Fish health monitoring specially during onset of winter and if required taking remedial measures. The farmers should have potassium permanganate at home for disease treatment as well as for prophylactic measure of fishes.
- **Growth parameters of the fishes:** Recorded at monthly interval through sample netting.
- **Harvesting:** Single or multiple harvesting advised based on size of fishes and demand. After 3 months harvesting may be initiated using drag net. Expected growth of fishes: Catla 700-1500 g, Rohu 500-800 g, Mrigal 500-700 g and Common carp 500-1000 g. The survival rate should be above 70%.

- **Yield (3rd Tier at the lower elevation):** The Production per ha in the grow-out ponds (under scientific management with application of pelleted supplementary feed): 3500-4000 kg ha^{-1} y^{-1} in the initial 1st and 2nd year and it should be > 4000-5000 kg ha^{-1} y^{-1} (from third year onward once the soil fertility and water retention improves).While using non pelleted feed the yield: 3000-4500 kg ha^{-1} y^{-1}

5. **Critical inputs required:** High density PP, Fish seed, Fish Feed, Fertilizer/ Manure/Lime

6. **Observation to be recorded:**

• Water depth and retention period • Rainfall
• Water quality
• Soil erosion and siltation

7. **Target users/ stakeholders:** MTTCs/ KVKs/Farmers/NOGs

8. **Precaution(s) with the technology:** Proper management of rain water harvesting from catchment areas through drainage system into ponds; precaution against damage of dyke, synthetic, checking soil erosion and controlling water pH.

9. **Advantage/ Benefits/ Utility of technology:** Small and seasonal use of upland areas available plenty in NE region converting them as water harvesting structures with rain water utilization suitably for seed production locally and utilizing the seed for grow out fish farming. Additional benefit of farmers by utilization of the dyke and catchment area for horticultural crops like pine apple, mango, litchi etc.

10. **Economics of the technology:**

- For construction of ponds (nursery, rearing and grow-out) cost may vary greatly with the states. In Tripura, it would be around Rs. 4-5 lakh ha^{-1} of total area.
- Besides these costs, the annual expenditure to be incurred towards operational cost to undertake intensified aquaculture would be Rs. 2.5 - 2.8 lakh ha^{-1}.
- Additionally, the cost for developing horticultural crops on the slope 2-2.5 lakh ha^{-1} would be required for pine apple.

11. **Technology developed under the project:** Technology was developed as a part of research initiatives of the College to make an 'Instructional Demo Unit' for the students and the farmers of the region as well as the findings of the PhD research work of Dr. M. Datta.

12. **Investigator(s)/inventor(s):** J. R. Dhanze, R. K. Saha, M. K. Datta and A. B. Patel: Email: mkdatta2005@gmail.com; ratankumarsaha123@gmail.com; Mobile: 8787857901; 9436122795

13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 10: Technology No. 01: Run-off water harvesting technology for fish- based farming system: 301-302.

Contact address:

Dean, College of Fisheries (CAU, Imphal), Lembucherra, Tripura- 799210 Email: cofcau.agt-tr@gov.in; cofcau@rediffmail.com.

TECHNOLOGY:
NECTAR-AC-47

1. **Name of the technology:** Fish-rice-vegetable-fruit based integrated farming system
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of adoption/development:** 2014
4. **Description of technology with salient features:**

The technology of fish-rice-vegetable-fruit farming system intervention is a location-specific scientific modification of traditional paddy-cum-fish culture which is beset with low fish production and only one crop of paddy is grown. In this present intervention, a scientific layout of the available land is planned in such a way that farmers can grow fish, rice, vegetable, and fruits simultaneously.

The minimum land required for this intervention is 0.5 ha in which 0.16 ha is considered for rice and vegetable culture; 0.30 ha for fish culture (in which 0.24 ha area is for the main water body and 0.06 ha for the channels); 0.04 ha area is for embankment in which the fruits and selective seasonal vegetables are cultivated. The proportional sharing of land for different components is as follows: Fish : Rice + vegetable : Fruit +/vegetable= 6 : 3.2 : 0.8. The proportional sharing of different components can be changed or modified according to the location, topography, and the availability of land under the proper guidance of the expert.

Generally, the front portion of the selected farm is chosen for the construction of a pond or main water body which is dug up to 1.0 – 1.5 m. Just behind the water body, the land area is used for rice cultivation in monsoon and vegetables in winter (**Fig. 4 & 5**). Channels of 1.5 to 2.0 m breadth with 0.5- 0.75 m deep are excavated from both adjacent sides of the main paddy field which is connected with the main water body (**Fig. 2 & 3**). During monsoon, paddy cultivation is done in the main paddy field, and during winter when the field is dried the vegetable cultivation is done. For fish culture, the available ditch and/or land renovated to channels and main reservoir/pond and also made use of water throughout the season for rice, fruit, or vegetable farming on the adjacent land. Along with that, the selected pond is treated with the quick lime (@ 300 -500 kg ha^{-1}), cow dung (@ 10000 -15000 kg ha^{-1}), MOC, etc. for optimization of the water quality for fish farming and to increase the amount of primary food in the pond water. To perform such activities, different inputs such as quality fish seed, balanced fish feed, lime, vegetable seeds, and different planting materials, etc. will be required.

The fish pond is stocked with five fish species which are stocked in the ratio of catla (3): silver carp (1): rohu (3): mrigal/ prawn (1.5): common/ amur carp (1.5). Initial stocking density should be @ 12,000 nos. ha^{-1} and periodical stocking @ 8,000 nos. ha^{-1}.

For rice cultivation, Gomati (Av. yield- 5.9 t ha^{-1}) variety is taken which is suitable under rainfed shallow lowland condition. After harvesting the rice, in post-monsoon or winter season various vegetables are cultivated. The vegetables

are mainly bottle guard, potato, ridge gourd, string bean, local bean, cabbage is suitable for pond embankment as well as adjacent plain land whereas the fruit crops like banana and papaya are planted on pond embankment.

NOTE:

Other fish species may be stocked as per availability of quality fingerlings *viz*., *Labeo bata, Labeo calbasu,* Talapia (*Oreochromis mossambicus*/*O. niloticus*), Koi (*Anabas testudineus*), Magur (*Clarias batrachus*), Singhi (*Heteropneustes fossilis*), *Channa striatus*, *C. punctatus, C. marulius* and *Puntius* spp.

Other promising rice verities for low-lying deep water/semi-deep-water *viz*., IB-1, IB-2, AR-1, 353-146 (Assam); Jaladhi-1, Jaladhi-2 (West Bengal); CAU-R4 (*Enotphou*), Thoddabi (Manipur); Jala- 1 (Tripura) may be used as per the preference of the farmers.

The findings of the impact of the technology in field conditions are furnished here. The total HH (house hold) covered under this technology was 4 nos. and area covered as 3.06 ha (Land Area= 2.01 ha; Water area= 1.05 ha).

Particular	**Fish**	**Rice**	**Vegetable**	**Fruit**	**Total, Rs HH^{-1} annum^{-1}**
	(av. pond area HH^{-1}, ha)	**(av. land area HH^{-1}, ha)**	**(av. land area HH^{-1}, ha)**	**(av. land area HH^{-1}, ha)**	
	0.12	**0.15 (*vegetable and rice have grown in the same field in different seasons)**		**0.02**	
Input per annum					
Fingerling, feed, lime, planting materials: papaya etc., banana sucker, vegetable seed, paddy seed, fertilizer, pesticide etc. cost, Rs HH^{-1}	5700	1800	10500	1600	19600
Renovation of pond etc. cost Rs HH^{-1}	43000*	-	-	-	-
Total Cost, Rs HH^{-1}	**5700**	**1800**	**10500**	**1600**	**19600**
Output per annum					
Production (av.), kg HH^{-1}	150 (1250 kg ha^{-1})	247.50 (1650 kg ha^{-1})	2565 (17100 kg ha^{-1})	21 (1050 kg ha^{-1})	-
Gross Income, Rs HH^{-1}	15000	6250	20100	2250	43600
Net Income, Rs HH^{-1}	**9300**	**4450**	**9600**	**650**	**24000**

*Renovation cost of pond etc. is not included during the calculation of B:C ratio

Fig. 1 Before intervention

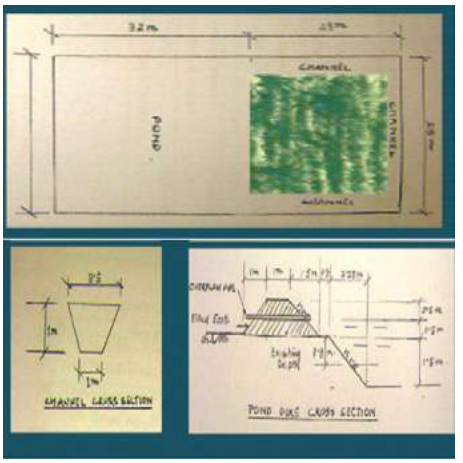

Fig. 2 Layout of the Field

Fig. 3 Renovation of field as per layout

Fig. 4 After intervention of the field including pond and channel

Fig. 5 Close up view of the paddy field, pond and dyke

Fig. 6 Vegetables in the field after paddy

Fig. 7 Farmer harvested bottle guard and other vegetables

Fig. 8 Harvesting of fishes

5. **Critical inputs required:**

- Quality fish seed, balanced fish feed, lime, vegetable seeds and different planting materials.

6. **Observation to be recorded:**

- Growth study of all the crops; yield of fish, rice, vegetable and fruit; BC ratio.

7. **Target users/stakeholders:** MTTCs/KVKs/SHGs/NGOs/progressive farmers

8. **Precaution(s) with the technology:**

- The farmers need to apply/stock the inputs at appropriate times and in appropriate quantity.
- Quality of inputs is of paramount importance

9. **Advantage/ Benefits/ Utility of technology:**

In the traditional paddy-cum-fish culture the production of fish is only 600-800 kg ha^{-1}. But in the present IFS system fish

production was recorded as 1,250 kg ha^{-1}. Before the intervention, the net income of the farmer was recorded as Rs. 9,300 HH^{-1} y^{-1}, and after the intervention, it was recorded as Rs. 24,000 HH^{-1} y^{-1} from the IFS model involving fish-rice-vegetable and fruit farming.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 2.22

11. **Technology developed under the project:** Project entitled "Livelihood Improvement and Empowerment of Rural Poor through Sustainable Farming Systems in North East India" under the sub project "Fish based farming system in Dhalai district of Tripura" funded by ICAR-World Bank Fund, NAIP, Component-III, New Delhi.

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13. **Technology publication(s):**

Saha, R. K. and Nath, D. (2012). Fish-rice-vegetable-fruit farming system: a livelihood option for small and marginal farmers in Dhalai, Tripura. p. 31-33. *In*: Book of Extended Summaries: The National Seminar on Livelihood Options for Small and Marginal Farmers in Fragile Ecosystems. pp. 125. Munda, G. C., Ngachan, S. V., Das, A., Mohapatra, K. P., Choudhury, B. U., Ramakrushna, G. I., Tripathi, A. K., Azad Thakur, N. S., Malngiang, S. and Chowdhury, S. (eds.). Pub: ICAR Research Complex for NEH Region, Umiam, Meghalaya.

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TECHNOLOGY:
NECTAR-AC-48

1. **Name of the technology:** Profitable farming system model of 'fish-vegetable-fruit'
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of release/ adoption/ development:** 2014
4. **Description of technology with salient features:**

- The technology of "fish-vegetable-fruit" farming system intervention is a location-specific scientific modification of less productive traditional fish culture techniques.
- In the traditional fish farming system, only fish culture is practiced in an unscientific way.
- In the modification of this traditional method, the available land is scientifically laid out with the renovation of farm ponds for retaining water throughout the year for fish culture. The adjacent land and pond dyke can also be utilized for fruit or vegetable farming and also to minimize soil erosion.
- The pond is supplemented with the quick lime (@ 300 -500 kg ha^{-1}), cow dung (@ 10000 -15000 kg ha^{-1}), fertilizer, etc. for optimization of the water quality for fish farming and to increase the primary productivity of the pond.
- Bamboo poles are fixed vertically and horizontally into the ponds in a zig-zag fashion to provide the substrate for the development/growth of the periphyton. Periphytons are the natural food for the fishes like *Labeo rohita*. Bamboo pole arrangement also protects fishes from poaching.
- This model was laid out on the farms of 41farmers. The farmers were provided with different inputs such as quality fish seed, balanced fish feed, lime, vegetable seeds, and different planting materials, etc.
- The stocking ratio of fish species was maintained as 6 species @ catla (2.5): silver carp (1.0): rohu (3): grass carp (0.5): mrigal (1.5): common carp/ amur carp (1.5).
- Initial stocking density was @ 12,000 nos. ha^{-1} and periodical stocking @ 8,000 nos. ha^{-1}.
- The vegetable (bottle guard, pumpkin, brinjal, local bean) cultivation was done on pond embankment as well as adjacent plain land and dyke whereas the fruit crops like banana, papaya, and pineapple were planted on pond embankment.
- The pond bottom mud/muck should be taken out at regular intervals with the help of a bucket and can be used regularly in the vegetable or fruit cultivation field as manure.

The total area covered 11.48 ha (Land Area= 7.2 ha; Water area= 4.28 ha) under this intervention. The findings of the impact of the technology in field condition are furnished below:

Particular	Fish	Vegetable	Fruit	Total, Rs HH^{-1} $annum^{-1}$
	(av. pond area HH^{-1}, ha)	(av. land area HH^{-1}, ha)	(av. land area HH^{-1}, ha)	
	0.12	0.16	0.10	
Input per annum				
Fingerling, feed, lime, banana sucker, pineapple sucker, vegetable seed, fertilizer, pesticide etc. cost, Rs HH^{-1}	12400	6700	3500	22600
Non recurring cost, Rs HH^{-1}	-	-	-	-
Total Cost, Rs HH^{-1}	**12400**	**6700**	**3500**	**22600**
Output per annum				
Production (av.), kg HH^{-1}	312 (2600 kg ha^{-1})	2400 (15000 kg ha^{-1})	1200 (12000 kg ha^{-1})	-
Gross Income, Rs HH^{-1}	31200	16800	9600	57600
Net Income, Rs HH^{-1}	**18800**	**10100**	**6100**	**35000**

Fig. 1 & 2 IFS model on 'fish-vegetable-fruit' (Banana trees and vegetables in the pond embankment)

Fig. 3 Pineapple plantation in the pond embankment (white ←—) and arrangement of bamboo poles (←—) in the pond

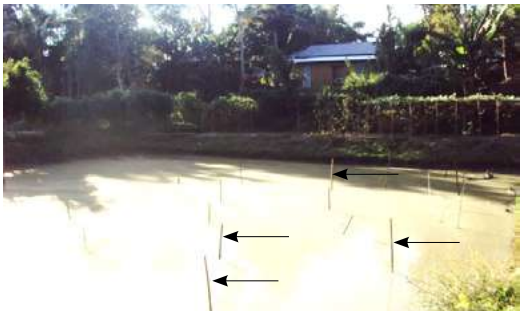

Fig. 4 Vegetable in the pond embankment and arrangement of bamboo poles in the pond

Fig. 5 Potato harvesting from adjacent land of the pond

Fig. 6 Netting operation in 'IFS' pond

Fig. 7 IFS model on 'fish-vegetable-fruit' (Coconut & Arica nut trees in the pond embankment)

Fig. 8 Dignitaries with Catla fish (3 kg weight)

5. **Critical inputs required:**

   Lime, cow dung, mustard oil cake (MOC), bamboo poles, quality fish seed, balanced fish feed, lime, vegetable seeds, different planting materials and medicines.

6. **Observations to be recorded:**

   Fish, vegetable and fruit growth performance, yield, diseases, BC ratio.

7. **Target users/stakeholders:** MTTCs/ KVKs/SHGs/NGOs/Farmers

8. **Precaution(s)with the technology:**

   - The farmers need to apply/stock the inputs at appropriate times and in appropriate quantity.
   - Quality of inputs is of paramount importance

9. **Advantage/ Benefits/ Utility of technology:**

   The farmers have enhanced their income after the intervention from fish as well as vegetable and fruit crops. The average productivity of fishes has increased as 2600 kg ha^{-1} (2,400 - 3,070 kg ha^{-1}) from 350 kg ha^{-1} after the intervention. Before the intervention, the average net income of the farmers was recorded as Rs. 16,500 HH^{-1} y^{-1} and after the intervention, it was recorded as Rs. 35,000 HH^{-1} y^{-1} from the IFS model involving fish-vegetable-fruit farming. The success of the target farmers has motivated other farmers also to take up this intervention which has increased their land productivity.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 2.55

11. **Technology developed under the project:** Project entitled "Livelihood Improvement and Empowerment of Rural Poor through Sustainable Farming Systems in North East India" under the sub project "Fish based farming system in Dhalai district of Tripura" funded by ICAR-World Bank Fund, NAIP, Component-III, New Delhi.

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TECHNOLOGY:
NECTAR-AC-49

1. **Name of the technology:** Farming system model based on 'fish-vegetable-fruit-pig' components

2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura

3. **Year of adoption/development:** 2014

4. **Description of technology with salient features:**

   The farming system model based on 'fish-fruit-vegetable-pig' is a very effective technology to integrate the fish culture activity along with different crops (fruit and vegetable) and animal (pig) components. It is considered to be an excellent innovation for the use of organic wastes. The farmers can derive benefits throughout the year by implementing the said technology in different ways such as by producing fish along with fruits, vegetables, and pigs. The main center point of the technology is the pond and its dykes were used for the cultivation of fruit, vegetable, and pig farming. The exotic upgraded stock of pig i.e., large - White Yorkshire is the most suitable variety for raising with fish culture. The pond should be stocked with six different fish species as per the principle of composite fish culture. Some salient features of the technology are given below:

- Before stocking the fish (seeds) fingerlings, the pond needs to be initially fertilized with the quick lime (@ 300 -500 kg ha^{-1}). After 7 days of liming, cow dung (@ 10000 -15000 kg ha^{-1}) is applied for optimization of the water quality for fish farming.

- The recommended stocking ratio of the six fish species are @ catla (2.5): silver carp (1): rohu (3): grass carp (0.5): mrigal (1.5): common/ amur carp (1.5).

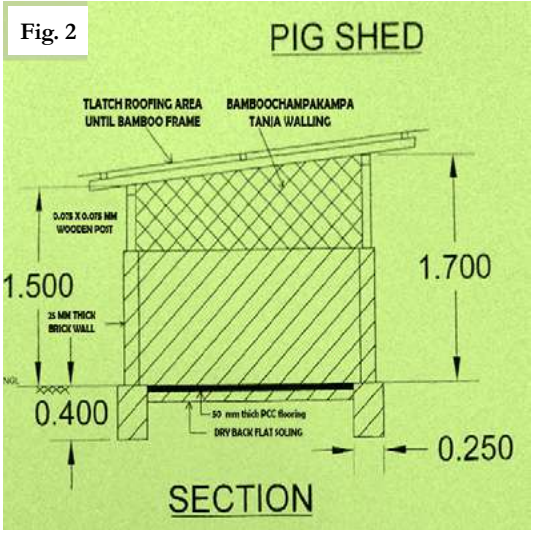
- In the experimental setup, the initial stocking density was at 12,000 nos. ha^{-1} and periodical stocking was done at 8,000 nos. ha^{-1}.

- The vegetable (bottle guard, pumpkin, brinjal, local bean, chilli) cultivation was done on the pond embankment as well as on adjacent plain land and dyke. However, the fruit crops like banana, papaya, and pineapple were also planted on pond embankment.

- The pond bottom mud/muck should be taken out at regular intervals with the help of a bucket and can be used as manure in the vegetable or fruit cultivation fields.

- Rearing of pigs can be fruitfully blended with fish culture by setting pig housing units on the pond embankment in such a way that the waste and washings of the pig house are drained out to the fish

Fig. 1 Pig shed on the pond embankment



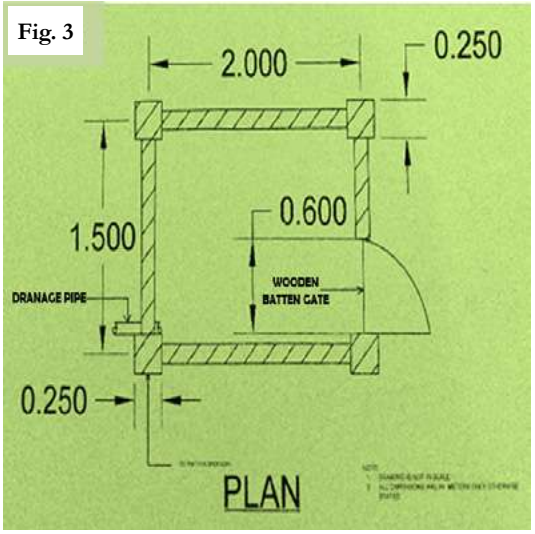


Fig. 2 & 3 Pig shed design (Sectional & Plan views: scale in m otherwise stated)

pond. This has to be regularly monitored. If algal bloom forms in the pond, draining out of washings of the pig house to the pond may be suspended for some time until the algal bloom subsides.

- The pig shed (**Figs. 1-3**) can be constructed with locally available materials. It is advisable to provide 1.0-1.5 m^2 space for each pig. The height of the pig house should not exceed 1.5 m. The floor of the house must be cemented.

- The advantage in this system is that no fertilizer or supplementary feed is required for the production of fish as the urine and excreta of the pig helps in increasing the pond productivity. The pig dung/excreta consist of 69 - 71% moisture, 1.3-2.0% nitrogen (N), 0.36-0.5% phosphate(P) and 0.2-0.3% potassium (K). However, the quality and quantity of excreta depend upon the feed provided and the age of the pigs.

- During one year, two crops of pigs (6 months each, only fattening) can be raised.

- When the first lot of pigs (30 – 40 pigs are adequate to fertilize one ha pond) is disposed of after 6 months, the quantities of excreta going to the pond decreases. This does not affect the fish growth as the organic load in the pond is sufficient for the next 2 months when new piglets grow to give more excreta.

- Required vaccination of the piglets/pigs should be done in consultation with the veterinary doctor.

- The pigs should be fed three times a day with a balanced pig diet as per their requirements and generally fed @ 1.4 kg pig^{-1} day^{-1}.

- Kitchen waste, grasses, water hyacinth/ aquatic plants, and green cattle fodder can also be provided to the pigs to reduce the feed cost.

- In the experimental setup, the total HH (household) covered under this technology was 7 nos. and area covered is 2.97 ha (Land Area= 1.85 ha; Water area= 1.12 ha) and details are given below:

Particular	Fish	Vegetable	Fruit	Pig	Total, Rs HH^{-1} $annum^{-1}$
	(av. pond area HH^{-1})	(av. land area HH^{-1})	(av. land area HH^{-1})	(No. HH^{-1})	
	0.16 ha	**0.15 ha**	**0.11 ha**	**2.0**	
Input per annum					
Fingerling, feed, lime, banana sucker, vegetable seed, piglet, fertilizer, pesticide, etc. cost HH^{-1}	13000	5800	2300	3600	24700
Non recurring cost (pig shed for 3 years) HH^{-1}	-	-	-	20000*	-
Total Cost, Rs HH^{-1}	**13000**	**5800**	**2300**	3600	**24700**
Output per annum					
Production (av.), kg HH^{-1}	432 (2700 kg ha^{-1})	765 (5100 kg ha^{-1})	286 (2600 kg ha^{-1})	300	
Gross income, Rs HH^{-1}	43200	6120	2780	18600	70700
Net income, Rs HH^{-1}	**30200**	**320**	**480**	15000	**46000**

Fig. 4 & 5 Before intervention whole family is involved in fishing activities

Fig. 6 View of farming system model

Fig. 7 View of vegetable and fruit fields on pond dyke and in adjacent land

Fig. 8 Hon'ble VC of CAU interacting with the farmer along with Dean (COF) and JD (ICAR Tripura Centre)

Fig. 9 Bottle gourd field

Fig. 10 View of IFS model: Fish-vegetable-fruit-pig

Fig. 11 Harvested fishes under IFS model

*Cost of pig shed is not included during the calculation of B:C ratio

Note: The income may vary on the productivity and market price of the inputs/ by-products

5. **Critical inputs required:**
   - Quality fish seed, piglets, balanced fish/pig feed, lime, vegetable seeds and different planting materials.
6. **Observation to be recorded:** Yield of fish, vegetable, fruit and pig; disease incidence; BC ratio
7. **Target users/stakeholders:** MTTCs/ KVKs/SHGs/NGOs/Farmers
8. **Precaution(s) with the technology:**
   - The farmers need to apply/stock the inputs at the appropriate time with the required quantity for better production.
   - The quality of inputs is of paramount importance.
   - Vaccination of piglets/pigs to be done in consultation with the expert.
   - Proper utilization/recycling of the pig waste in fertilization of pond to be done to make the waste into wealth.
9. **Advantage/ benefit/ utility of technology:**

   The farmers are going to enhance their economic status by adopting this type of fish-based farming system model i.e.,

'Fish-fruit-vegetable-pig'. This is found as more effective as compared to others in the NEH region. The average production of fish increased to 2.7 t ha^{-1} even to 5.0 t ha^{-1} in some cases after proper intervention as compared to the initial average productivity of 0.35 t ha^{-1}.

10. **Economics of the technology/ Benefit: Cost Ratio:** Before intervention= 1.57; After intervention= 2.86

11. **Technology developed under the project:** NAIP, Component-III, ICAR-World Bank funded project entitled "Livelihood Improvement and Empowerment of Rural Poor through Sustainable Farming Systems in North East India" under the sub project "Fish based farming system in Dhalai district of Tripura".

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TECHNOLOGY:
NECTAR-AC-50

1. **Name of the technology:** Fish-goat-fruit: A promising farming system model

2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura

3. **Year of adoption/development:** 2014

4. **Description of technology with salient features:**

   The "Fish-goat-fruit" farming system model was experimented at the Dhalai district of Tripura by COF, CAU, Lenducherra, Tripura under the NAIP project site. This is a farmer's friendly innovative technology that integrates the fish culture activity along with fruit and goat farming. The farmers would derive benefit from the intervention in different ways such as by producing fish, fruits, and goats. The salient features of the technology are:

- Six fish species *viz*., catla (2.5): silver carp (1): rohu (3): grass carp (0.5): mrigal (1.5): common carp/amur carp (1.5) having different feeding habits are generally maintained.

- The initial stocking density was @ 12,000 nos. ha^{-1} and periodical stocking @ 8,000 nos. ha^{-1}.

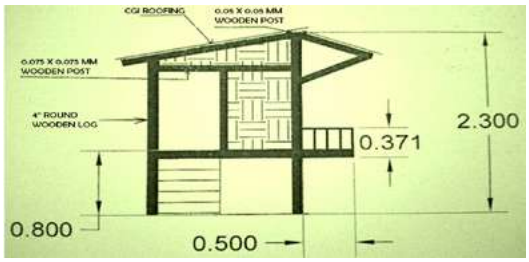

Fig. 1 Goat shed design (Sectional view: scale in m otherwise stated)

- The fruit crops like banana and papaya were planted on pond embankment.

- Two (2) nos. of black Bengal goat kid were introduced per unit. It is advisable to provide a 1.5 m^2 space for each goat. The goat shed (Size: W x L= 1.5 m x 2.0 m) was constructed with locally available materials as per the design shown in **Figs. 1-3**. This type of shed should be built on a high platform about 0.8-1.0 m high from the floor to provide a better drainage system. The roof height should be of 1.3-1.5 m from the loft or platform.

- The study revealed that the goat's excreta are considered as a very good organic fertilizer (C: 40- 60%, N: 2.7-3.0%, P: 1.0-1.78%, K- 2.0-2.88%) and its urine is also equally rich in both N and P.

- Thus, by adopting the technology the use of fertilizer and supplementary feeds for fish farming can be replaced by goat's excreta and its urine.

- Furthermore, the feeding cost of goats is almost negligible as they are free-grazing animals. As a result, the integration of goats with fish farming minimizes the input cost and maximized fish productivity.

- It was estimated that at least 50-60 goats are essential to fertilize 1 ha pond.

- The total HH covered under this technology was 6 nos. with an area of 1.15 ha (Land area= 0.41 ha; Water area= 0.74 ha). The findings of the impact of the technology in field condition are furnished below:

Particular	Fish	Goat	Fruit	Total, Rs HH^{-1} $annum^{-1}$
	(av. pond area HH^{-1}, ha)	(kg per unit HH^{-1})	(av. land area HH^{-1}, ha)	
	0.12	1 Unit	0.06	
Input per annum				
Recurring cost HH^{-1}	12500	1750	3000	17250
Non recurring cost (Goat shed) HH^{-1}	-	3320*	-	-
Total Cost, Rs HH^{-1}	**12500**	**1750**	**3000**	**17250**
Output per annum				
Production (av.), kg HH^{-1}	330 (2750 kg ha^{-1})	26 (meat)	-	-
Gross Income, Rs HH^{-1}	59400	7800	3900	71100
Net Income, Rs. HH^{-1}	**46900**	**6050**	**900**	**53850**

*Cost of goat shed is not included during the calculation of B:C ratio

5. Critical inputs required:

- Quality fish seed, goat kids, balanced fish feed, lime, vegetable seeds and different planting materials.

6. Observation to be recorded:

- Yield of fish, fruit and goat, diseases, BC ratio

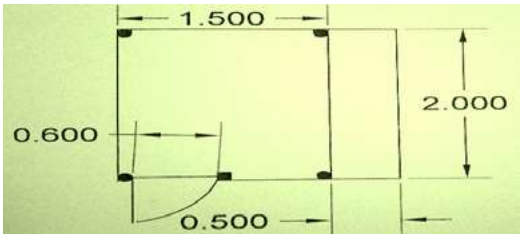

Fig. 2 Goat shed design (Plan view: scale in m)

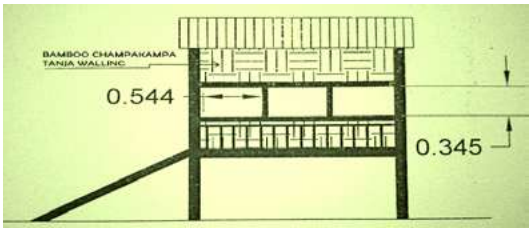

Fig. 3 Goat shed design (Front view: scale in m)

Fig. 4 Goat shed under construction on the pond embankment

Fig. 5 Completed goat shed

Fig. 6 & 7 Fish-goat-fruit IFS models in farmers field

7. **Target users/stakeholders:** MTTCs/ KVKs/SHGs/NGOs/Farmers

8. **Precaution(s) with the technology:**

   - Timely given the input to farmers
   - Maintain the quality of inputs

9. **Advantage/ Benefits/ Utility of technology:**

   The productivity of fish pond under the conventional/traditional fish farming system (before intervention) was around 400- 600 kg ha^{-1}. However, after the implementation of the technology the productivity of fish pond was enhanced to 2,750 kg ha^{-1} (2,600 – 3,150 kg ha^{-1}). Furthermore, before the intervention, the average net income from the farmers' practice was found Rs. 11,000 HH^{-1} $year^{-1}$ (Rs. 8000-12,000 HH^{-1} $year^{-1}$) whereas after intervention it was enhanced to around Rs. 53,850 HH^{-1} $year^{-1}$.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 4.12

11. **Technology developed under the project:** Project entitled "Livelihood Improvement and Empowerment of Rural Poor through Sustainable Farming Systems in North East India" under the sub project "Fish based farming system in Dhalai district of Tripura" funded by ICAR-World Bank Fund, NAIP, Component-III, New Delhi**.**

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13. **Technology publication(s):**

Saha, R. K., Nath, D. and Goswami, P. (2014). Final Report of NAIP (Component III) Sub-project: Fish based farming system in Dhalai district of Tripura: Pub: COF, CAU, Lembucherra, Tripura, Indian, pp 1-70.

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TECHNOLOGY:
NECTAR-AC-51

1. **Name of the technology:** Waste into wealth: Fish-mushroom farming model
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura-799210
3. **Year of adoption/development:** 2014
4. **Description of technology with salient features:**

   Fish-mushroom based farming was experimented in the NAIP project site at Dhalai Tripura by COF, CAU, Lembucherra, West Tripura. In the present model, fish farming was integrated with the mushroom culture.

   The shed of mushroom culture (size: W x L x H= 2.7 m x 7.5 m x 2.149-2.549 m) was made on pond embankments which get the required moisture from pond water, this model minimizes the time/labour require for moisturizing the mushroom bed and ensure the easy availability of water. Mushroom cultivation fits in very well for sustainable farming and has several advantages. It uses agricultural waste products, and provide a high production per surface area.

   After harvesting the mushrooms, the spent substrate can be used as a good soil conditioner and as pond fertilizer for the production of plankton, which reduces the use of supplementary feeds. Hence, this integration system reduces the input cost and increase the net income of the farmers.

Fig. 1 Mushroom shed on pond embankment

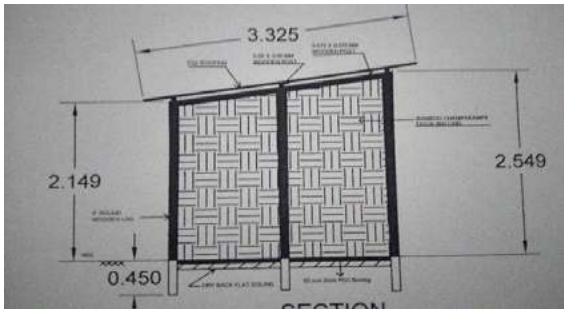

Fig. 2 Mushroom shed design (scale in m otherwise stated)

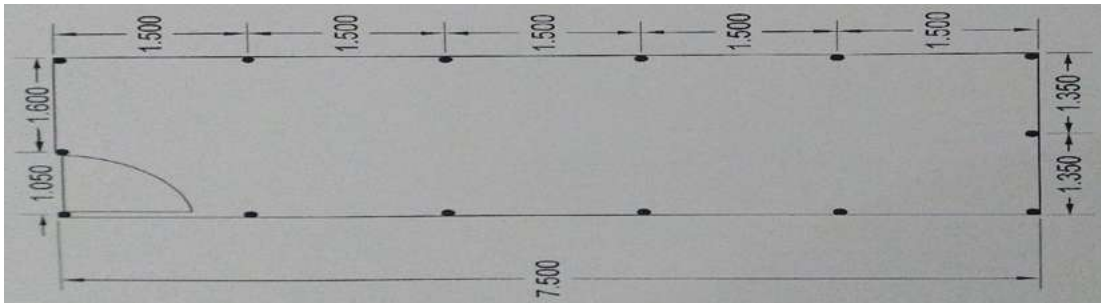

Fig. 3 Mushroom shed design (Plan view: scale in m otherwise stated)

Fig. 4 Distribution of mushroom spawn/seed

Fig. 5 Mushroom bed inoculated with seed

Fig. 6 Inside of mushroom shed

Fig. 7 Mushroom beds ready to harvest

Fig. 8 Harvested mushroom beds hanged in to the ponds

The stocking ratio of 6 (six) fish species was maintained at catla (2.5): silver carp (1): rohu (3): grass carp (0.5): mrigal (1.5): common carp/ amur carp (1.5). The initial stocking was done @ 12,000 nos. ha^{-1} and periodical stocking @ 8,000 nos. ha^{-1}. The total HH (household) covered under this technology was 6 nos. and 0.78 ha (Land area= 0.05 ha; Water area= 0.73 ha) area was covered. The findings of the impact of the technology in field condition are furnished below:

Particular	Fish (Av. pond area HH^{-1}) 0.12 ha	Mushroom (No. of Unit HH^{-1}) 1 Unit	Total, Rs HH^{-1} $annum^{-1}$
Input per annum			
Recurring cost HH^{-1}	14000	3500	17500
Non recurring cost (Mushroom shed) HH^{-1}	-	12796*	-
Total Cost, Rs HH^{-1}	**14000**	**3500**	**17500**
Output per annum			
Production (av.), kg HH^{-1}	3242700 (kg ha^{-1})	72	-
Gross Income, Rs HH^{-1}	58320	14400	72720
Net Income, Rs HH^{-1}	**44320**	**10900**	**55220**

* Cost of mushroom shed is not included during the calculation of B:C ratio

5. **Critical inputs required:**

   - Quality fish seed, balanced fish feed, lime, quality mushroom spawn, BC ratio.

6. **Observation to be recorded:**

   - Yield of fish and mushroom

7. **Target users/stakeholders:** MTTCs/ KVKs/SHGs/NGOs

8. **Precaution(s) with the technology:**

   - Timely input supply to the farmers
   - Maintain the quality of inputs

9. **Advantage/ Benefits/ Utility of technology:**

   From the study, it concluded that the present intervention enhanced the average productivity of fishes from 650 kg ha^{-1} to 2700 kg ha^{-1}. Furthermore, an additional income realized from the mushroom production. Before the intervention, the net income of the farmers was recorded as Rs. 11,000 HH^{-1} y^{-1} and after the intervention, it was recorded as Rs. 55,220 HH^{-1} y^{-1} from this model involving Fish-mushroom culture. Thus, there was an average 5-fold increase in income for the farmers.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 4.16

11. **Technology developed under the project:** Project entitled "Livelihood Improvement and Empowerment of Rural Poor through Sustainable Farming Systems in North East India" under the sub project "Fish based farming system in Dhalai district of Tripura" funded by ICAR-World Bank Fund, NAIP, Component-III, New Delhi.

12. **Investigator(s)/inventor(s):** R. K. Saha, Dillip Nath, P. Goswami and H. Saha; Email: ratankumarsaha123@gmail.com; Mobile: 9436122795

13. **Technology publication(s):**

Saha, R. K., Nath, D. and Goswami, P. (2014). Final report of NAIP (Com. III) sub-project: Fish based farming system in Dhalai district of Tripura: Pub: COF, CAU, Lembucherra, Tripura, Indian, pp. 1-70.

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TECHNOLOGY:
NECTAR-AC-52

1. **Name of the technology:** Utilization of detoxified rubber seed meal for fish feed formulation
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of adoption/development/ publication:** 2014
4. **Description of technology with salient features:**

Rubber seed is an important by-product of rubber cultivation in many tropical countries. However, the yield of seed is largely wasted. Globally, India is the 2nd in productivity, 4th in production and consumption and 5th in area with 5,97,000 ha. From a hectare of plantation, 300-400 kg seeds are produced per year. Thus, on a rough estimation, approximately 2,38,800 MT of rubber seeds are produced annually in India. The kernel of rubber seed is roughly half of the weight of the total seed. The kernel contains 20% protein with 40-50% unsaturated oil. Thus, from India alone, 1,19,400 MT of kernel is produced every year. However, much of this valuable resource is unutilized and this untapped resource can be used for feeding aquatic animals after converting it to suitable non-toxic form. The technology that has been developed to prepare detoxified rubber seed meal (**Fig. 1**) from the rubber seed kernel, which can be utilized as non-conventional protein feed ingredients in aquafeed is presented here. The cyanogenic glycoside levels were found to be low in processed rubber seed meal. It can be used up to 200 g kg^{-1} of feed without any toxic effect in the fish. **The technology can also be upscaled to commercial levels.**

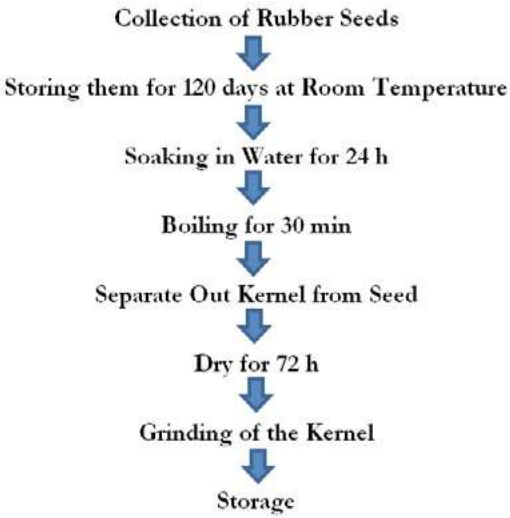

Fig. 1 Preparation and Detoxification Steps for Rubber Seed Meal

Table 1 Proximate composition of raw rubber seed and Detoxified rubber seed meal (n=3)

Parameter	Raw rubber seed		Detoxified rubber seed meal	
	Mean	SD	Mean	SD
Moisture (g kg^{-1})	38.0	2.0	16.0	2.0
Protein (g kg^{-1})	175.0	2.0	254.0	4.0
Fat (g kg^{-1})	480.0	9.0	391.0	16.0
Ash (g kg^{-1})	31.0	6.0	24.0	2.0

Fibre (g kg^{-1})	72.0	4.0	75.0	4.0
Carbohydrate (g kg^{-1})	314.0	23.0	332.0	25.0
Cyanide (mg kg^{-1})	415.1	16.2	60.1	8.2

Fig.2 Rubber seed and other forms

5. Critical inputs required:

Equipment required:

- Feed manufacturing machine
- Boiler
- Other items: Fuel, labour, packing material

6. Observation to be recorded:

- HCN (mg kg^{-1})
- Crude Protein (%)
- Fibre (%)
- Lipid (%)
- Ash (%)
- Moisture (%)

7. Target users/stakeholders: Industry/ KVKs/MTTCs/SHGs/NGOs

8. Precaution(s) with the technology:

- Raw rubber seed should be stored in bulk as it is available only at particular season
- Storage of the seeds should be done after proper drying
- Dried seeds should be kept at dry places

9. Advantage/ Benefits/ Utility of technology:

- Can be used for preparing fish feed and other livestock feeds by replacing conventional mustard oil cake
- Non-conventional protein fish feed ingredient and reduced the cost of fish feed drastically

10. Economics of the technology:

Fixed cost		Working cost for producing 1 kg Rubber Seed Meal	
Particulars	**Cost (in lakh)**	**Particulars**	**Cost (in Rs)**
Processing Unit	1.00	Rubber Seed (approx. 2.5 kg)	10.00
Weighing balance	0.25	Electricity	1.00
Miscellaneous	1.00	Labour	5.00
Total Fixed Cost	**2.25**	Miscellaneous	1.00
		Total production cost of rubber seed meal (Rs kg^{-1})*	**17.00**

*** Note:** In wholesale markets of NE India, the price of Mustard Oil Cake price is around Rs 30 kg^{-1}.

11. **Technology developed under the project:** MFSc Thesis Work. Thesis submitted to CAU, Imphal

12. **Investigator(s)/inventor(s):**

    B. B. Sharma, R. K. Saha and H. Saha, Email: sahacofcau@gmail.com/ ratankumarsaha123@gmail.com; Mobile: 9774325853; 9436122795

13. **Technology publication(s):**

    Sharma, B, B., Saha, R. K. and Saha, H. (2014). Effects of feeding detoxified rubber seed meal on growth performance and haematological indices of *Labeo rohita* (Hamilton) fingerlings. *Animal Feed Science and Technology*, **193**: 84-92. DOI:10.1016/j.anifeedsci.2014.03.008.

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TECHNOLOGY:
NECTAR-AC-53

1. **Name of the technology:** Seed production of zebra fish (*Danio rerio*) in aquarium condition
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of adoption/ development / publication:** 2015
4. **Description of technology with salient features:**

   Zebra fish (*Danio rerio*) is an important indigenous ornamental fish of India and it has got commercial importance in international trade. But, seed production of Zebra fish in captive condition is always a difficult task, a scientific method of seed production of zebra fish (*Danio rerio*) under aquarium conditions is developed.

Flow chart for seed production of zebra fish (*Danio rerio*)

Danio rerio fry should be collected from the wild

↓

The fry is needed to be acclimatized and stocked in two rectangular cemented tanks (500 l capacity) for about two months

↓

One aquarium of 50 l capacity to be used with sponge filter to supply continuous oxygen

↓

Add mixture in equal proportion of live food (mixed zooplankton), formulated feed, and commercial aquarium feed (floating) at the rate of 5% body weight

↓

Feeding should be done twice daily

↓

Fecal matter and leftover feed should be removed by siphoning and 20% of the water volume to be changed daily

↓

A photoperiod of 12:12 h light: dark cycle should be maintained during the rearing period

↓

Recommended rearing period approximately 7 months

↓

After seven months, natural breeding to be initiated by maintaining male and female brood stock in 1:1 ratio

↓

After spawning, hatching takes place within 24-36 h

↓

Feeding of live food (mixed zooplankton) to hatchlings should be started from the third day onwards after hatching

↓

Artificial feed to be given from 15th day onward

↓

The Zebra fish seeds will be ready for marketing after 2 months of rearing

Fig. 1 Bloodstock pair used for breeding

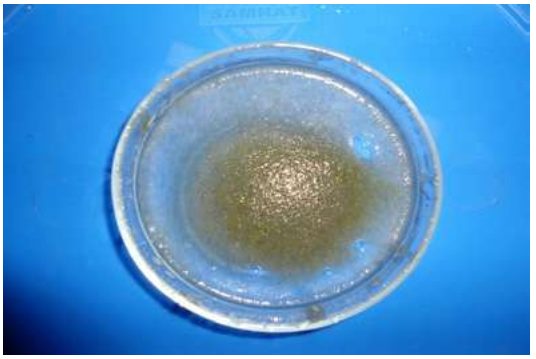

Fig. 2 Mixed zooplankton (live food)

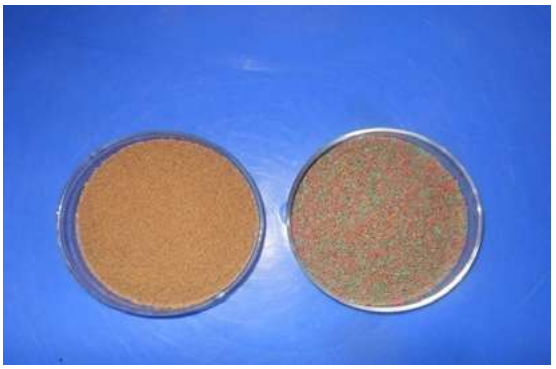

Fig. 3 Formulated feed and commercial feed

Fig. 4 One-month old zebra fish

5. **Critical inputs required:**
   - Aquarium of suitable size, good source of water, filtration system with aeration, healthy brood stock, nutritionally balanced feeds, hand nets, plankton nets, spawning baskets, hand pelletizer for making feeds, live food for larval rearing.
6. **Observation to be recorded:**
   - Water quality parameters like pH, dissolved oxygen (DO) and temperature
   - Health of fish
   - Growth performance, survival of fish
   - Maturity of fish, spawning of fish and larval survival
7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs/SHGs/NGOs/ Farmers
8. **Precaution(s) with the technology:** Proper brood stock management, optimum water quality and larval rearing
9. **Advantage/ Benefits/ Utility of technology:** Commercial seed production is possible in indoor system as backyard unit with minimum input cost
10. **Economics of the technology/ Benefit: Cost Ratio:** B: C ratio: 1:2
11. **Technology developed under the project:** CAU funded IRP entitled "Effect of feeding strategies on captive breeding of indigenous ornamental fish species, *Colisa fasciata* and *Danio rerio* in Tripura".

12. **Investigator(s)/inventor(s):** S. C. Mandal, M. K. Datta and A. B. Patel**:** Email: scmandal02@gmail.com, Mobile: 9862807933.

13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 10: Technology No. 04: Seed production of zebra fish (*Danio rerio*) in aquarium condition: 304-305.

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TECHNOLOGY:
NECTAR-AC-54

1. **Name of the technology:** Low cost seed production of Pabda (*Ompok bimaculatus*)
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of adoption/ development/ publication:** 2015
4. **Description of technology with salient features:**

   Ompok bimaculatus, commonly known as Pabda or Indian butter cat fish has recently gained attention as a promising aquaculture candidate owing to its good taste, excellent nutritional profile and high market value. Breeding is induced through hormone therapy using Ovaprim or Ovatide or WovaFH and more recently Ovasis and GonoPro. College of Fisheries, Lembucherra has developed a modified version of an indigenous micro-hatchery. The uniqueness of the technology is the use of low-cost inputs without much space obligation. Any marginal farmer can produce Pabda seed in small scale which can meet his own requirement as well as can sell to local farmers which will fetch a handsome amount of money. The technology has been demonstrated to interested fish farmers both in on-campus and off-campus modes. The trained farmers are now continuing their seed production without much complication.

   Low cost homestead Pabda hatchery: The unit comprised of 3 nos. water holding system made up of bamboo made frame with polythene sheet and 2 nos. of 500 l glass aquariums.

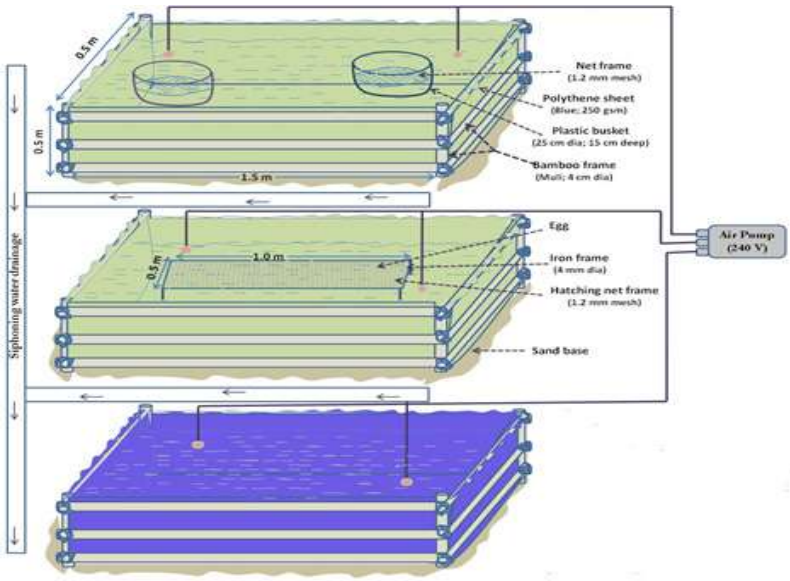

Fig. 1 Design of low-cost homestead pabda hatchery unit

Fig. 2 Breeding happa

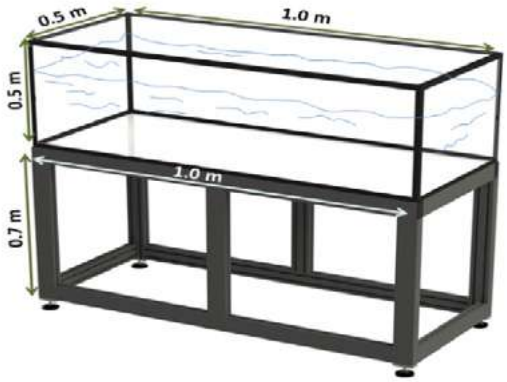

Fig. 3 Aquarium with stand

The settled filtered pond water can be used for hatching the eggs. For incubation the fertilized eggs are uniformly distributed in the specially made net baskets which are kept in glass aquarium. The hatching is expected to take place within 24 h at a temperature range of 27-30˚C. The water depth should be kept at 14-15 cm. The system can accommodate 15000-20000 fertilized eggs in one aquarium at an approximate hatching rate of 60-80%.

Specifications/facilities/materials required for hatchery:

S. No.	Items	Specification	Use/Remarks
1	Brood stock Hapa	2 m x 1 m x 1 m; Nylon net; mesh size 1.5 mm	For keeping the brood stock before and after injection
2	Bamboo frame	1.5 m x 0.5 m x 0.5 m; 4 cm dia	To support the water holding system
3	Polythene Sheet	250 gsm; Preferably blue colour	To hold water for egg incubation and larval rearing
4	Plastic basket	25 cm dia; 15 cm deep	For spreading the egg uniformly on the net for incubation
5	Hatching net frame	1.2 mm mesh; Nylon mosquito net	For easy removal of egg shells after hatching
6	Iron frame	1 m x 0.5 m x 0.3 m	To support hatching net
7	Sand base	5 cm thick	To give a uniform bottom and lowering the temperature
8	Air pump	240 Volt	For providing aeration
9	Aquarium	1 m x 0.5 m x 0. 5m; 250 l cap.	For egg incubation, hatching and larval rearing
10	Aquarium stand	Iron framed; 1 m x 0.5 m x 0.7 m	For supporting the aquarium

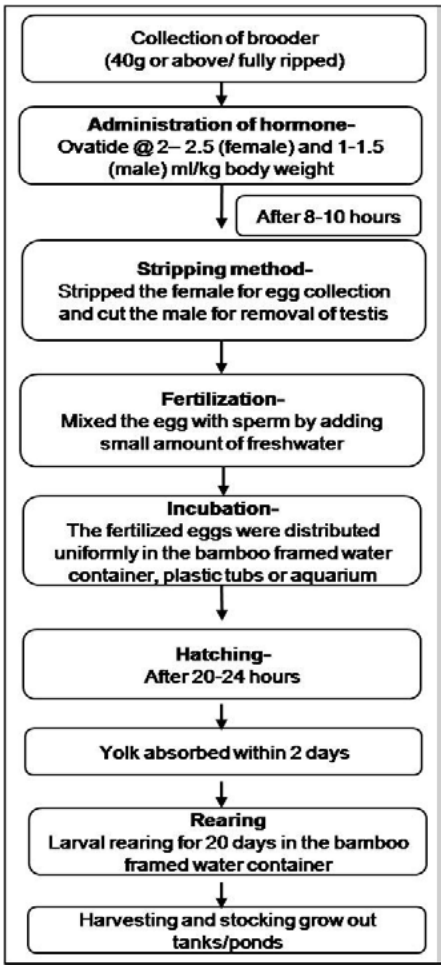

Fig. 4 Flowchart of Breeding activities

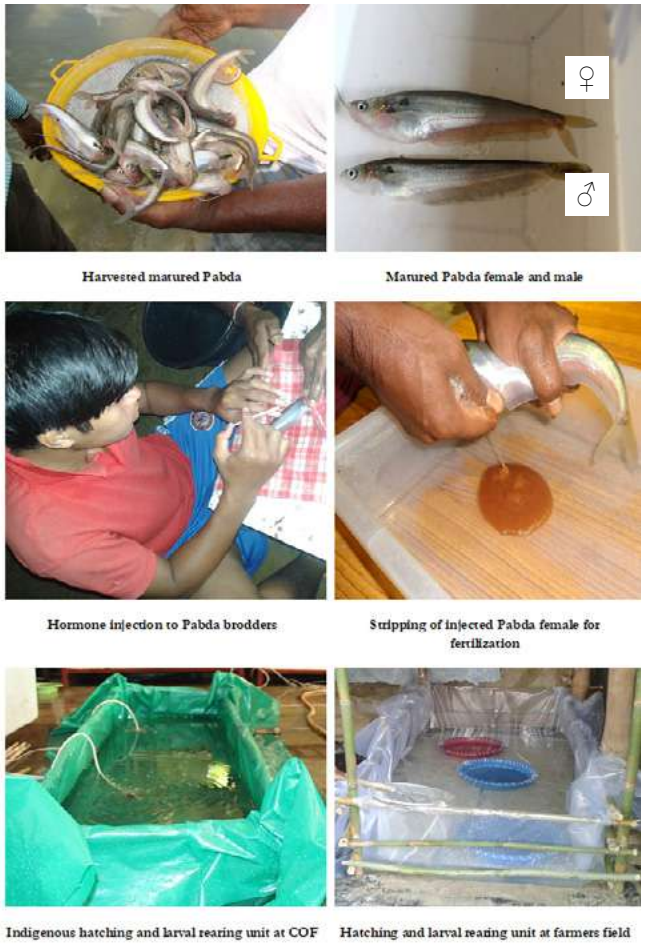

Fig. 5 Breeding activities

After hatching, the larvae will come out of the net basket and settle at the bottom corner of the tanks. The larvae are reared in the same incubation tanks. After yolk sac absorption, the larvae are fed with live plankton and finely chopped tubifex larvae. After 14th day of hatching, the larvae can be fed with powdered dried fish egg twice a day @ 25% of the body weight to obtain better survival and growth of fry. The larvae grow to 15-20 mm fry during 15-21 days of rearing. After a maximum of 21 days rearing in the indoor, they should be transferred to out-door rearing tanks for fingerling production. The uniqueness of the technology is to use of low-cost inputs without any much space obligations. Any marginal farmer can produce. The trained farmers are now continuing their seed production without much complications.

5. **Critical inputs required:** Pabda brood fish, inducing hormone (Ovatide), sterile 1 ml syringe, scissors and forceps, plastic tray (36 cm x 24 cm x 6.5 cm), bamboo made frame with polythene sheet (2 m x 1 m), dried fish eggs., air pump, plastic tub (20 l), and bucket, nylon hapa (3 m x 4 m).

6. **Observation to be recorded:**

- Maturity level of male and female fish
- Cannibalism and mortality
- Egg fertilization and hatching rate
- Water quality parameters (Temp., pH, DO)

7. **Target users/stakeholders:** MTTCs/ KVKs/Farmers

8. **Precaution(s) with the technology:** The handling of brooders should be stress free during breeding operation. Proper time gap should be maintained between injection of inducing hormone and stripping process. The fertilized eggs should be evenly spread to allow all hatched out larvae to pass through the net and settle at the bottom. Larvae should be fed four times a day to avoid cannibalism. Water exchange @ 50% d^{-1} should be done daily with mature ground water.

9. **Advantage/Benefits/Utility of the technology:** This low-cost technology for seed production of Pabda can be practiced by small and marginal farmers with mere investment of Rs. 10,000.00 which will enable him/her to produce seed for own requirement as well as for selling to fellow farmers worth of Rs. 50,000. The production can be up scaled depending on the availability of broodstock and facility.

10. **Economics of the technology/ B: C ratio:** 1:4

11. **Technology developed under the project:** DBT, GOI funded project entitled "Centre of excellence on fisheries and aquaculture biotechnology".

12. **Investigators/inventor(s):** P. Biswas, R. K. Saha and P. K. Pandey: Email:pradyutbiswas@gmail.com; Mobile: +91 8014496141

13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 10: Technology No. 05: Low cost seed production of Pabda (*Ompok bimaculatus*): 305-307.

Biswas, P., Jena, A. K., Saha, H. and Chowdhury, T. G. (2018). Induced breeding and seed production of Pabda: a species with potential for aquaculture diversification in northeast India. *World A*quaculture, **49**(1): 41-45.

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TECHNOLOGY:
NECTAR-AC-55

1. **Name of the technology:** Floating grow-out supplementary carp feed: COF: CAU-GCFF

2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura

3. **Year of adoption/ publication/ evelopment**: 2015

4. **Description of technology with salient features:**

   The main objective of the technology is to produce a suitable floating extruded fish feed in the North-Eastern region utilizing feed ingredients available in the local markets namely rice bran, mustard oil cake, corn, wheat, rice, wheat bran, dry fish meal. The feed formulation and production conditions of the floating supplementary grow-out carp feed 'COF: CAU-GCFF' has been standardized. The formulation has been refined for optimal physical characteristics (water stability, floatability and pellet size), nutritional parameters (proximate composition), cost of the feed and the feed efficiency.

   The produced feed has been extensively evaluated at pilot scale at the college farm. Further, the feed has also been extensively utilized by ICAR research complex for NEH Region, Tripura station, Department of fisheries, Govt. of Tripura, KVKs in different northeastern states of Tripura, Assam, Arunachal Pradesh and Mizoram.

Procedure/methodology: The feed ingredients of good quality are purchased in bulk from the local market. After arrival of ingredients at the feed plant, proximate compositions of ingredients are analyzed in the laboratory for accurate formulation of floating COF: CAU-GCFF. Subsequently, floating supplementary carp feed is produced by subjecting ingredients to the following sequence of processes/ production line:

Procurement → Transportation to feed mill plant → Drying → Grinding → Mixing → Conditioning → Extrusion → Drying → Cooling → Packing → Storage → Use/Sale

Each of these processes is crucial in terms of quality adherence and requires requisite skills to ensure best quality of feed. Floating type twin screw extruded feed pellet of diameter 3-5 mm of high-water stability (>1 hour) of following nutritional contents are produced:

• Crude protein: 22 - 24%	• Crude Fiber: 10 - 15%
• Crude lipid: 3 - 4%	• Ash: 10 - 12%
• Digestible carbohydrate: 45 - 52%	• Moisture: 6-9%

The manufacturing conditions for floating pellets of 3-5 mm diameter have been standardized for pilot scale production by twin screw extruder:

• Water addition: 17.5%	• Extrusion Temperature: Zone I-160°C, Zone II-175°C, Zone III-170°C,
• Feeder speed: 25-28 rpm	• Twin Screw speed: 29-32 rpm

• Cutter speed: 20-26 rpm	• Oven temperature: 115°C
• Time of Drying: 18-20 minutes in belt dryer	

The extensive biological evaluation of produced floating pellet have been conducted for carps in monoculture and polyculture in fertilized earthen ponds and outdoor cement tanks provided with soil base. The apparent feed conversion ratio (AFCR) has been found to be 1.8-2.2. (Culture period six months, stocking density 15000 ha^{-1}, daily feeding rate: 4-3% biomass d^{-1}, feeding frequency; twice a day (@ 9-10 am, and 3-4 pm, half of ration on each occasion)

Proximate composition: The produced feeds are tested for proximate composition including crude protein, crude lipid, crude fiber, ash and moisture content for quality adherence to ensure above mentioned nutritional characteristics. The extensive biological evaluation of produced floating pellet for carps in monoculture and polyculture in fertilized earthen ponds have resulted an apparent feed conversion ratio (AFCR) of mean 1.8-2.2 (Culture period six months, stocking density 15000 ha^{-1}).

FCR: 1.8-2.2

Shelf life of the feed: It is recommended to be used within 3 months if stored properly in dark, dry and cool place. It is to emphasize that proper storage of feed is critical to shelf-life.

Remark:

The technology pertains to production of an end- product viz. efficient floating supplementary feed for carps for use under outdoor culture system of pond or tanks utilizing locally available ingredients. The formulation is propriety component and may be shared to public institutions upon formal request with due acknowledgment.

5. Critical inputs required: To produce the floating feed, following critical inputs are essential:

- Fixed Input: Functional feed mill (Dryer, grinder, mixer, conditioner, extruder pelletizer)
- Consumables: Feed ingredients: (corn/ maize, rice bran, wheat, tuber crop, mustard oil cake, dry fish meal, soybean meal cake, any locally available/producible protein or carbohydrate source etc.), technician, labor and electricity

6. Observation to be recorded:

• Floatability and water stability of feed	• Feed acceptability by fish
• Fish growth	• Proper storage of feed (cool and dry place)
• Regular feeding by farmer	• Planktonic productivity of pond and water quality of ponds

Target users/stakeholders: Multi Technology Testing Centers (MTTCs)/ KVKs/SHGs/NGOs Farmers

8. **Precaution(s) with the technology:** The feed must be stored in dark, cool and dry place. The best practices of storage should be adopted and feed should be regularly checked for physical, chemical and microbial damages and/ or contamination. Feeding (3-4% of fish biomass) should be done regularly at the same time and same place in the pond. Feeding response should be monitored regularly, if feeding response is low, feeding should be stopped and fish health need to be checked. Also, when consistent cloudy weather is persisting, feeding rate should be reduced. In winter feeding rate should be reduced to 0.5-1.0%.

9. **Advantage/ Benefits/ Utility of technology:** Advantages of extruded feeds are:

   a. Ease in Feeding and labor cost saving
   b. Ease in monitoring of feed consumption
   c. High water stability of feed
   d. Improved digestibility
   e. Denaturation of antinutritional factors

10. **Economics of the technology/Benefit: Cost Ratio:** 1: 1.6.

    Apparent feed conversion ratio is indicative of economics. Economics of feeding is dynamic with cost of feed/ feed ingredients and market price of fish. Considering FCR 2.2, at current price of feed as Rs. 36 kg^{-1} and locally produced fish 200 kg^{-1}, the return on feed cost would be net return on feed cost as 177% and gross return on feed cost as 277%. Further, multi-locational trials including in Tripura and Arunachal Pradesh has indicated 18-35% increase in net return over conventional feeding with farm-made feeds.

11. **Technology developed under the project:**

    Developed under research initiative of the College of Fisheries, CAU (Imphal), Lembucherra, Tripura.

12. **Investigator(s)/inventor(s):**

    A. B. Patel, M. K. Datta and S. C. Mandal**:** Email: arun.b.patel@gmail.com; Mobile: 9436540812

13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K, Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 10: Technology No. 02: Floating supplementary carp feed CAU AQUA Feed (carp) by using locally available ingredients: 305-307.

Hussain, S. M., Patel, A. B., Pathak, M., Pandey, A.K. Singh, M. P. (2015). Comparative Study on use of Floating Pelleted fish feed and local Practice of feeding in Composite Fish Culture (CFC) in East Siang district Arunachal Pradesh. 43-48. *In*: R. N. Bhuyan, D. Ghosh, S.M. Kharbuli, R. Nath, (eds.). Proceedings of the national seminar on Aquaculture in north east region: Realities, opportunities and challenges held on 25-26 August, 2015 at St. Anothony's College, Shillong, Meghalaya. pp. 183.

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TECHNOLOGY:
NECTAR-AC-56

1. **Name of the technology:** Live wolffia–based fingerling production of rohu *(Labeo rohita*)

2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura

3. **Year of adoption/ development/ publication:** 2015

4. **Description of technology with salient features:**

   Rohu (*Labeo rohita)* is one of the most popular fish cultured in India and hence efficient and quality fingerling production of this species is of high importance. Currently, fingerling of rohu is produced in outdoor tanks/ponds using artificial feeds ranging from simple farm made feed to more complex formulated feeds. Besides high feed cost, use of feeds has often led to deterioration in water quality due to leaching and/or accumulation of uneaten feeds leading to erratic survival and growth. We developed an alternative fry rearing technology for rohu fingerling production based on live-wolffia that can be easily grown by farmers on-farm and is not only cost effective and environmentally efficient but also resulted in remarkably superior survival, growth and quality of fingerlings. It is notable that Wolffia (*Wolffia globosa)* is the smallest flowering plant (length-0.68 mm and width-0.34 mm) on the earth, and has high turnover rates, high quality protein content, low fiber content, low antinutritional factors, high digestibility and excellent floatability.

   Technology: The rearing was undertaken in six (6) outdoor cement tanks (5m x 4m x1m)provided with soil base (8-10 cm). The tanks were subjected to pre-stocking preparation viz. tanks were drained & dried, limed (250 kg ha^{-1}), filled with ground water and manured with cow dung (1000 kg ha^{-1}) and pre-soaked mustard oil cake (100 kg ha^{-1}). 20-d old rohu fry were stocked at a stocking density of 3 lakh ha^{-1} after clear 10-d of fertilization when clear sign of planktonic production was evident. Rohu fry in three (3) tanks selected randomly were fed with grounded extruded artificial feed (crude protein 28%) while the rest of three tanks were fed with live wolffia freshly harvested from an earthen pond (crude protein 28%). The feed rate of both feed and live wolffia were same on dry matter basis 8-10% d^{-1} of the fish biomass. Feeding frequency for artificial feed was twice a day, once 9-10 a.m. and in the afternoon at 3-4 pm with half of the ration on each occasion. Live wolffia was grown on pilot scale on-farm in an earthen pond and required quantity of live wolffia for daily feeding was harvested from the pond (**Fig. 1**).Notably, live wolffia was applied only once a day in the morning as it floats whole day and beyond if not consumed. The feeding rate of wolffia on fresh weight basis was 150-200% of the biomass.

   Performance: After 45-d of rearing, the final mean weight of rohu fed on live wolffia was 7.8 g against only 2.4 g with artificial feed (**Fig. 2**). Similarly, mean survival of rohu also was markedly high (89.5%) compared to that of artificial feed (69.7%) (**Fig. 3**). Furthermore, apparent feed conversion ratio of live wolffia (0.54) also was remarkably low in comparison to that of artificial feed (1.06) (**Fig. 4**).

Fig. 1 Harvest of live wolffia for feeding

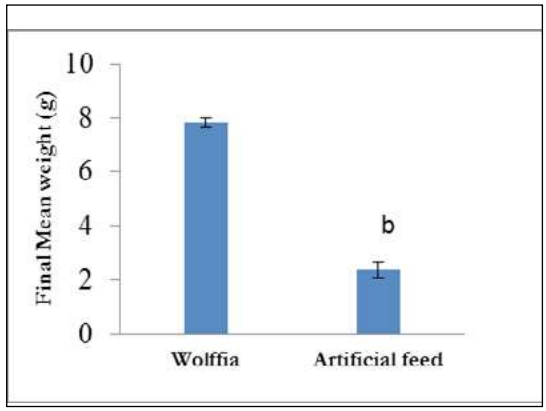

Fig. 2 Relative growth performance of rohu fingerling on live wolffia and artificial feed

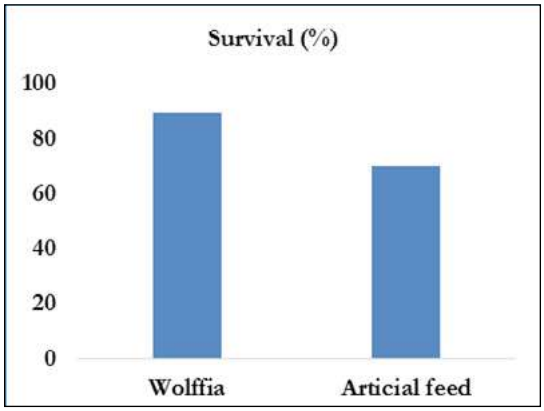

Fig. 3 Relative survival of rohu fingerling on live wolffia and artificial feed

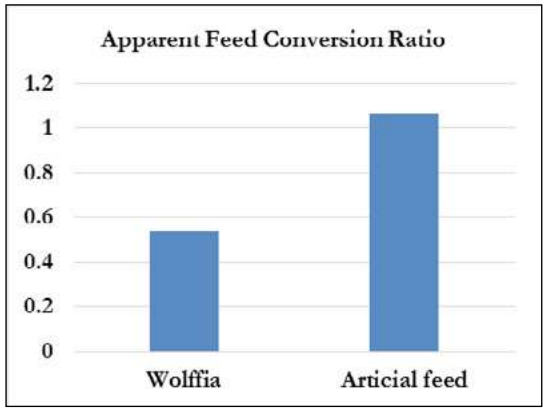

Fig. 4 Relative feed utilization efficiency of live live wolffia and artificial feed

5. Critical inputs required:

- Material for pre-stocking pond preparation (Lime, manure, mustard oil cake, fertilizer, soap-oil emulsion, etc.).
- Live Wolffia-inoculum, shallow water pools (depth 25-30 cm).

6. Observation to be recorded:

- Pre-stocking preparation of tank/pond
- Feeding response and vigor of stocked fry to feed and live wolffia
- Fish growth and overall quality of fry
- Water quality (pH, alkalinity, dissolved oxygen particularly in the morning)

7. Target users/ stakeholders: Any person/organization/body interested in producing rohu fingerlings.

8. Precaution(s) with the technology: On-farm culture of wolffia in a separate pond/ tank/lined water body with water column depth 25-50 cm and daily harvest before feeding. One of the main precautions of technology is labour involvement in fertilization of wolffia culture unit (twice a week), harvesting and transportation due to high moisture content.

9. Advantage/ Benefits/ Utility of technology: Salient advantages are as follows:

• Low cost technology	• Self-reliance
• Excellent acceptability	• High growth
• High survival	• Superior health status of fingerling
• Only one time feeding	• Ease of monitoring of feeding response
• Better environmental quality due to limited/ no leaching or deposition on sediment	

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 3.5

11. **Technology developed under the project:** DBT, GOI funded project "Centre of Excellence on Fisheries and Aquaculture Biotechnology"

12. **Investigator(s)/inventor(s):** A. B. Patel, P. K. Pandey, A. Pradhan, H. Priyadarshi**;** Email: arun.b.patel@gmail.com; Mobile: 9436540812**.**

13. **Technology publication(s):**

Pradhan, A., Patel, A. B. and Singh, S. K. (2019). Evaluation of live duckweed, *Wolffia globosa* as an allochthonous feed for *Labeo rohita* fry during nursery rearing. *Aquaculture Research*, **50**(6): 1557-1563.

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TECHNOLOGY:
NECTAR-AC-57

1. **Name of the technology:** Farming system model 'water reed-fish-veg-fruit' as a profitable livelihood option
2. **Source of the technology:** KVK- Imphal East, DEE (CAU, Imphal**)**
3. **Year of adoption/development:** 2017
4. **Description of technology with salient features:**

Fig. 1 Land before intervention

Water reed or water rush or water club rush (*Schoenoplectus lacustris* Linn) an aquatic terete herb belonging to family Cyperaceae, locally called as "Kouna" in Manipur is used in making a variety of handicraft products ranging from ladies' bag to slippers, hat, floor mat, cushion chair, etc. This aquatic plant is cultivated in the wet lands of Manipur valley and is a good source of income. Cultivation and promotion of water reed not only boosts the economy and enhance employment opportunity, but also helps in conservation of wetlands. Nowadays, Kouna craft has become one of the flourishing industries among handicrafts in the state due to abundant supply of raw material and ever-expanding markets. The present technology has been developed by introducing this water reeds as a commodity in the farming system and details are described below:

Site Selection:

Unproductive paddy fields, low lying areas, wetlands with good source of water and spacious benches/plots can be brought under this system (**Fig. 1**).

Plot Design: (**Fig. 2**)

The plot should be designed in such a way that it should meet the requirement of both water reed and fish. Peripheral trenches are constructed on one side of the field keeping a depth of about 1.5 m depth to retain water and also for easy harvesting of the fishes. Strong and stable dykes are constructed around the plot creating a confinement for fish and to retain more water.

Land Preparation for water reed plantation:

The plot/land for plantation is ploughed twice in a criss-cross pattern before filling with water. water is filled up to of 10-15 cm. Again, the plots are ploughed once more in a criss-cross pattern during which fertilizers in form of NPK @ 60:30:30 is applied followed by puddling and leveling. Then the soil is allowed to settle for at least 3 days before transplantation of the reeds.

Water reed plant transplantation:

Transplantation of water reed is carried out in lines maintaining a distance of 2 feet between plant to plant and row to row. After 15-20 days of transplantation (i.e. after the reed plants are established) the water level is increased to 1.5-2.0 feet which is most suitable for growth and development of water reed plant. If the water body is deeper, the plant become thicker and taller, this is not suitable for making good quality products. Further details are given below:

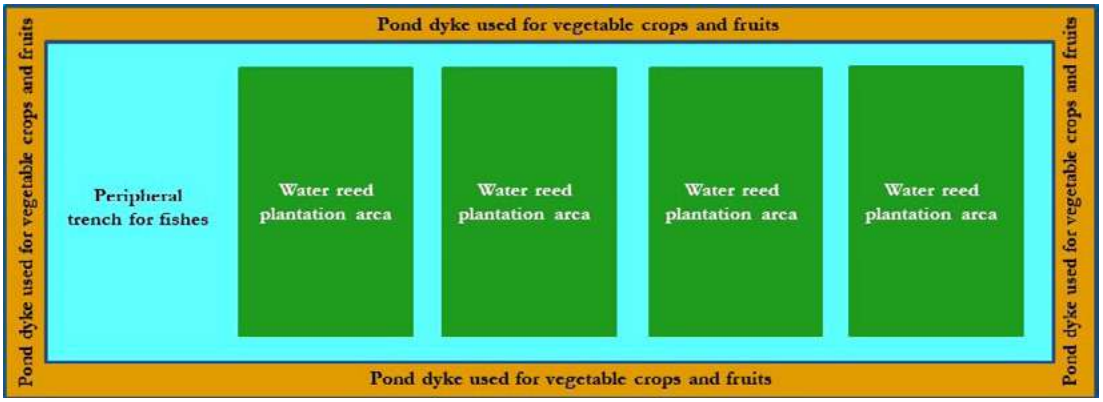

Fig. 2 Lay out of the plot for Water reed-fish-vegetable farming system

- **Water reed plantation time:** April -May
- **Spacing of water reed:** 2 ft x 2 ft (plant to plant and row to row)
- **No of water reed plants:** 16800 Nos. ha^{-1}

Selection of fish species: The species selected should

- Thrive in shallow water
- Tolerate temperature fluctuations
- Withstand high turbidity
- Grow to marketable size in a short period in other words have short life cycles
- Some successful species are rohu, common carp and mrigal

Fish rearing:

After completing one month of transplantation, advance fingerlings of Rohu, Common carp and Mirgal to be stocked at the ratio of 5 : 2.5 : 2.5 with a stocking density of 6000 Nos. ha^{-1}. supplementary fish feeding should be given twice daily @ 3% body weight and total culture period will be 6 months thus two fish harvestings in a year are possible.

Vegetable crops:

Seasonal vegetables *viz.*, cabbage and cauliflower (2500 plants 723 m^{-2}); king chili (324 plants 23 m^{-2}) to be cultivated at the specified areas as shown in the **Fig. 2**.

Fruit plants:

Fruit plants *viz.*, banana (84 plants)/papaya (84 plants) in 723 m^2 areas to be planted as specified in the **Fig. 2.**

Production details:

Water reed yield: 20000-22000 kg ha^{-1} y^{-1}

Vegetable production: Cabbage & Cauliflower: 3750-4000 kg 723 m^{-2}; King Chili: 130-150 kg 723 m^{-2}

Fruit: Banana 80-100 bunch 723 m^{-2}; Papaya 1500-2000 kg 723 m^{-2}

Fig. 3 Transplantation of water reeds and banana plantation and vegetables on the dyke

Fig. 4 King chili and vegetables on the dyke

Fig. 5 Havesting of water reeds

Fig. 6 Selling of water reeds

Fish Production: 1800-2000 kg ha^{-1} y^{-1}

5. Critical inputs required:

- Quality water reed plants, vegetable and fruit seeds/planting materials and fish seed.

6. Observation to be recorded:

• Growth of water reeds, vegetables and fruit plants	• Disease incidence
• Health and growth of fishes	• BC ratio

Fig. 7 Harvesting of fishes

Fig. 8 Harvested fishes for sale

Fig. 9 Farmer women attending training programme for making diff. products out of water reeds

Fig. 10 Products of water reeds

7. **Target users/stakeholders:** MTTCs/ KVKs/ SHGs/ NGOs / progressive farmers

8. **Precaution(s) with the technology:**

   - Timely availability of the input to farmers
   - Maintaining inputs quality.
   - Designing and construction of plot/ fields.

9. **Advantage / Benefits / Utility of technology:**

   - Water reed thrives very well under extreme climatic conditions of flood as well as drought.
   - Once planted it lasts for 15-20 years.
   - Culture of fish in water reed fields generally benefits water reed plants; as a result of greater tilling due to the movement of fishes.
   - Water reed plant acts as substrate to enhance food availability for fishes through periphyton development. The periphyton in turn act as feed for the fishes thereby increasing fish production.
   - Increase the luster quality of reed due to scrapping of periphyton colonized on the reed stalk by the fishes.

10. **Economics of the technology/Benefit: Cost Ratio:** 3.60 (in first year) and 5.27 (from second year onwards)

11. **Technology developed under the project/programme:** On Farm Trial (OFT) and Front-Line Demonstration (FLD)

12. **Investigator(s)/inventor(s):** M. A. Salam, O. Gunajit, Ch. Nandini, R. K. Saha and M. Premjit Singh; Email: salam555@rediffmail.com Mobile No: 8414814058.

13. **Technology publication(s):**

Salam, M. A., Medhabati Devi, T. and Oinam, G. (2017). It happens this way: A success story of water reed cum fish farming of Imphal East District Manipur. *CAU Farm Magazine*, 7(3): 29-30.

Anon. (2018). Water reed (*Scirpus lacustris*) cum fish farming. Genesis Dynamics of farm innovation. Pub: ICAR-Agricultural Technology Application Research Institute (ATARI), Zone-VII Umiam-Meghalaya. March, pp. 7-8.

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TECHNOLOGY:
NECTAR-AC-58

1. **Name of the technology:** Incorporation of Silver barb *Barbonymus gonionotus* (Bleeker) in feed-based seasonal carp polyculture pond system
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of adoption/ development/ publication:** 2014
4. **Description of technology with salient features:**

The main objective of the technology is to enhance fish productivity and farmers' income, especially from feed-based fish culture in seasonal water bodies with effective culture period of 5-6 months. The present technology has been developed to incorporate silver barb into seasonal grow-out culture of Indian and Amur common carp through multi-year trials. Silver barb has remarkably higher demand and fetch 10-20% higher market price compared to *Catla catla* and Cirrhinus mrigala, and 50-60% *Hypopthalmicthys molitrix* (silver carp) and *Ctenopharyngodon idella* (grass carp) of 100-150 g sizes. Due to remarkably low prices of silver carp and grass carp, particularly in Tripura at sizes less than 500g, these two species have been eliminated from the culture system.

Technical: Ponds are prepared as per standard pre-stocking preparation protocols. The overall stocking density of fingerlings of Indian major carp, common carp and silver barb is 12,000 ha^{-1} (size: 10-30 g of IMCs, 10 g of Amur common carp and 2-5 g of silver barb). The silver barb is stocked at 20-30%, *viz.* 2400 or 3600 $ha^{-1}$of total stocked number. The rest, *viz.* 9600-8400 $ha^{-1}$is stocked with Indian major carps namely rohu, catla, mrigal, and Amur common carp in the ratio of 1:1:0.5:0.5. Both levels of incorporations enhanced fish yield owing to higher specific growth rates of silver barb (2.79-3.14% d^{-1}) as compared to those of 0.7 to 1.6 % d^{-1} shown by IMCs and 1.3% d^{-1} of Amur common carp. This results in 15-25 % increase in economic return to the farmer owing to higher market prices over eliminated Chinese carps namely silver carp and grass carp as well as over catla and mrigal among Indian major carps of sizes < 500 g.

5. **Critical inputs required:** Pelleted feed, fertilizer, and manure. Regular feed quantity adjustment commensurate

to fish biomass increase in the pond, weekly fertilization with combination of inorganic fertilizers and cow dung (4 kg Urea, 6 kg SSP and 200 kg cow dung ha^{-1})

6. **Observation to be recorded:** Growth rates of different stocked fishes, feeding response and vigor of fishes, pond water colour, transparency (if < 20 cm, feeding to be stopped).

7. **Target users/stakeholders:**

   Multi Technology Testing Centers (MTTCs)/KVKs/SHGs/NGOs/ Farmers

8. **Precaution(s) with the technology:**

- Market price and salable size of silver barb should be ascertained beforehand.
- Incorporation level should be based on market price and water temperature (>20°C-30°C)
- Silver barb is a voracious feeder and hence use of good quality commercial pelleted feed is warranted, preferably floating one should offer at 4-5% of the biomass daily (feeding twice, 8-10 am, and 2-3 pm, with half of ration on each occasion).

9. **Advantage/ Benefits/ Utility of technology:**

- Faster growth of silver barb
- High market demand and price of even small sized silver barb
- Relatively uniform growth
- Ease of seinability of silver barb
- Higher Income of farmers

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 1.6-2.0 (depending on employing hired or family labour)

11. **Technology developed under the project:**

    Research conducted under Experiential Learning Programme-Aquaculture

12. **Investigator(s)/inventor(s):**

    A. B. Patel, M. K. Datta and S. C. Mandal: Email:arun.b.patel@gmail.com; Mobile: 9436540812

13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 10: Technology No. 03: Incorporation of Silver barb *Puntious gonionotus*(Bleeker) in feed-based carp polyculture pond system with particular reference to seasonal pond in NE region: 303-304.

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TECHNOLOGY:
NECTAR-AC-59

1. **Name of the technology:** Medicated feed for ameliorating the effect of low pH and waterborne iron stresses in fish
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of adoption/ development/ publication:** 2018
4. **Description of technology with salient features:**

- In polluted or contaminated water, fishes are continuously exposed to several environmental stressors. Among several stressors, low water pH and heavy metal toxicity (such as iron) became primary factors of concern in aquaculture especially in North Eastern parts of India where the soil and water are highly acidic with excess iron due to high content of ferrous ions and high rainfall.
- In the North Eastern region of India, natural springs and dug wells are the only cost-effective and viable means of fulfilling the needs of freshwater for aquaculture. The iron content in water is relatively high and groundwater in almost all states contains iron above the permissible limit.
- Conventionally synthetic chemotherapeutic agents were being used either for correcting the water chemistry or for minimizing the effect of environmental stress, as well as preventing and curing of different aquatic disease outbreaks.
- Furthermore, these chemicals are very corrosive in nature resulting in an accumulation of its residues in the aquatic ecosystem that has a detrimental effect on fish health and aquatic biodiversity. Moreover, the chemotherapeutic drugs like antibiotics can also lead to the development of drug resistance pathogenic microorganisms, thus raising food safety concerns.
- Hence, an eco-friendly product has been developed which can be used to ameliorate the detrimental effect of stresses (mainly low pH and waterborne iron) in the fish without any detrimental effect on the environment and biodiversity. Nutraceutical diet was prepared by incorporating a combination of *W. somnifera* root extract and vitamin C along with other ingredients in the required quantity. Pellets are made, dried at room temperature, packed in polythene bags and stored for further use.

- **The technology is ready for commercialization.**

Fig. 1 Herbal extract

Fig. 2 Medicated feed

5. **Critical inputs required:**

- Ingredients for the preparation of Medicated Feed:
  a) Nutraceuticals
  b) Fish Feed Ingredients
  c) Ethanol
- Equipment required:
  a) Drier
  b) Stirrer/shaker
  c) Centrifuge
- Other items: Fuel, labour, packing material

6. **Observation to be recorded:**

- Growth rate
- Relative percentage survival

7. **Target users/stakeholders:** Industry/ Consumers/SHGs/NGOs

8. **Precaution(s) with the technology:**

- Collection of original medicinal herbs and nutraceuticals
- Storage of the formulated feed
- Overfeeding may lead to immunosuppression in fish

9. **Advantage/ Benefits/ Utility of technology:**

- Incorporation of mixture of nutraceuticals at specific formulation can ameliorate the effect of multiple stresses (low pH and waterborne iron toxicity) in Fish.
- Feeding a fish with the dietary supplementation for minimum 7 days can increase the relative survivability of fish from 0 to 65% under multiple stresses.
- It may help in promoting growth of fish
- It is eco-friendly
- Reduces the usage of chemotherapeutants like quick lime for correcting water
- The formulation may reduce the biodiversity loss due to water quality managements in aquaculture ponds

10. **Economics of the technology/ benefit:**

Input	Requirement $kgha^{-1}y^{-1}$	Price ($Rs\ kg^{-1}$)	Traditional (Rs)	Innovation (Rs)
Lime	2,000	15	30,000	Not recommended
Feed	4000	30	1,20,000	1,20,000
Nutraceutical	40	562.50	Not Applicable	22,500
		Total Cost	1,50,000	1,42,500
Benefits: Minimum profit of Rs 7,500 $ha^{-1}\ y^{-1}$				

11. **Technology developed under the project:** DST, GOI, New Delhi funded project entitled "Dietary supplementation for restoring health and growth of fish during chronic exposure to water borne iron and acidity in Tripura".

12. **Investigator(s)/inventor(s):**

H. Saha, R. K. Saha and C. Laltlanmawia: Email: sahacofcau@gmail.com; ratankumarsaha123@gmail.com; Mobile: 9774325853; 9436122795.

13. **Technology publication(s):**

Laltlanmawia, C., Saha, R. K., Saha, H. and Biswas, P. (2019). Ameliorating effects of dietary mixture of *Withania somnifera* root extract and vitamin C in *Labeo rohita* against low pH and waterborne iron stresses. *Fish & Shellfish Immunology*, **88**: 170-178.

Contact address:

Dean, College of Fisheries (CAU, Imphal), Lembucherra, Tripura-799210. Email:cofcau.agt-tr@gov.in; cofcau@rediffmail.com.

TECHNOLOGY:
NECTAR-AC-60

1. **Name of the technology:** Bamboo leaf extract based dietary formulation against multiple stresses in fish
2. **Source of the Technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of adoption/ development/ publication:** 2017
4. **Description of technology with salient features:**

- Bamboo plants and its parts including leaves have number of health benefitting substances like antioxidants, anti-inflammatory substances, anticancer substances and has properties like antihelmintic, prebiotic, immunostimulant, antihypertensive, antiviral, antifungal, antibacterial and antiallergic etc.
- The main factors behind these novel properties of bamboo are various phytochemicals. Phytochemicals or botanicals referred as a diverse group of phytogenic active compounds like flavonoids, alkaloids, phenolics, ascorbic acid, saponin, rotenin, terpenoids, steroids, essential oils etc.
- These secondary plant metabolites are having immense potential for the development of new pharmacological entities and can be further tried in aquaculture for the benefit of fish farmers. Furthermore, bamboo plants are abundantly found in the north-eastern part of India.
- However, bamboo leaves are not been utilized for any commercial purpose until now in this part of the region. The product has been developed using the leaves of bamboo plants for boosting the immunity of fishes as well as to ameliorate the effects of stresses. **The technology is ready for commercialization**.

Preparation of Bamboo Leaves Alcoholic (BLAL) Extract: The protocol is given in **Fig. 1.**

Feeding trials revealed that the fish fed with the formulated feed containing Bamboo Leaves Alcoholic (BLAL) extract is having no toxicity effect on fish and based on the haemato-immuno-biochemical parameters of blood it was could concluded that the feeding for about 7 days gives best response. The efficacy of BLAL extract to enhance the resistance of fish against low pH, fungal infection (*Saprolegnia parasitica*) and bacterial infection (*Aeromonas hydrophila*) were tested.

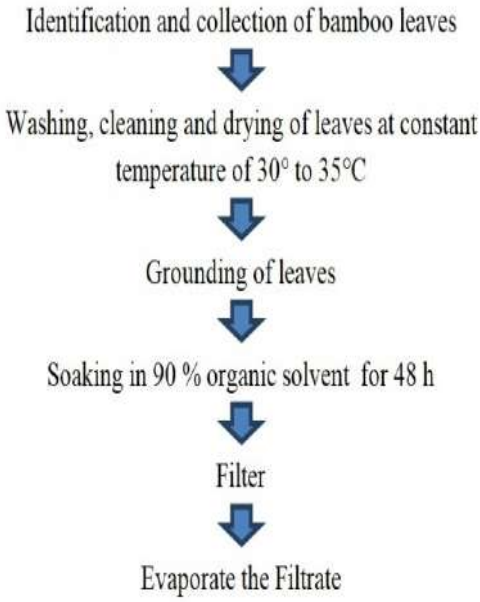

Fig. 1 Flowchart for preparing BLAL in brief

Fig. 2 BLAL based Feed (Left) and Bamboo leaves (Right)

5. Critical inputs/ equipment/ items required:

(i) Ingredients for the preparation of medicated Feed:

a) Bamboo leaves

b) Ethanol or water

c) Basic feed ingredient

(ii) Equipment required:

Hot plate, Feed pelletizer

(iii) Other items:

Fuel, labour, packing material

6. Observation to be recorded:

- Growth rate
- Relative percentage survival

7. Target users/stakeholders: Industry/ Consumers/SHGs/NGOs

8. Precaution(s) with the technology:

- Collection of bamboo leaves
- Storage of the formulated feed
- Overfeeding may lead to immunosuppression in fish

9. Advantage/Benefits/Utility of technology:

- Incorporation of the extract ameliorate the effect of stresses due to low pH
- It can be used as preventive measures against Saprolegniasis or bacterial infection
- It may help in promoting growth of fish
- It is eco-friendly
- Reduces the usage of chemotherapeutants like quick lime in water
- The formulation may reduce the biodiversity loss due to water quality managements in aquaculture ponds

10. Economics of the technology/ Benefit:

Input	Requirement kg $ha^{-1} y^{-1}$	Price (Rs kg^{-1})	Traditional (Rs)	Innovation (Rs)
Lime	2,000	15	30,000	Not recommended
Feed	4000	30	120,000	120,000
Nutraceutical	4	600	Not Applicable	2,400
		Total Cost	**150,000**	**1,22,400**
Benefits	**Minimum production cost reduction by Rs 27,600 $ha^{-1} y^{-1}$**			

Technology developed under the project: DST, GOI, New Delhi funded project entitled"Dietary supplementation for restoring health and growth of fish during chronic exposure to water borne iron and acidity in Tripura".

12. Investigator(s)/inventor(s):

H. Saha, R. K. Saha and Md. Idrish: Email: sahacofcau@gmail.com/ ratankumarsaha123@gmail.com; Mobile: 9774325853; 9436122795

13. Technology publication(s):

Idrish, R. K., Saha, R. K. and Saha, H. (2017). Muli bamboo (*Melocanna baccifera*) leaves ethanolic extract a non-toxic phyto-prophylactic against low pH stress and saprolegniasis in *Labeo rohita* fingerlings. *Fish & Shellfish Immunology*, **74**: 609-619. DOI:10.1016/j.fsi.2017.11.047.

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TECHNOLOGY:
NECTAR-AC-61

1. **Name of the technology:** CAU (Imphal)-*BRSHTI*: A low cost *in-situ* hatchery for carp seed production

2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura

3. **Year of adoption/development/ publication:** 2017

4. **Description of technology with salient features:**

   CAU (Imphal)-BRSHTI is suitable for seed production of medium and minor carps, which are of high demand in the North Eastern States. The design of *CAU (Imphal)-BRSHTI* is based on the structural principles of conventional eco-hatchery, but differs fundamentally in scale, cost, mode of installation, operation, water filtration, and temperature control.

   Hatchery Design &Assembly: The hatchery consists of four units: Water filtration cum thermal regulation chamber (Unit-A), Spawning tank (Unit-B), Incubation tank (Unit-C), and Fry collection chamber (Unit-D). While different units are interconnected using non collapsible flexible pipes as depicted in the aerial view of the hatchery (**Fig. 1**), Unit-B & Unit-C are also connected from bottom for automatic flow of eggs to incubation tank (**Fig. 2**). Bucket of Unit-A has a single inlet below 40 centimeter of water surface (**Fig. 2**), to ensure entry of only cool water inside hatchery during sunny days. Submersible aquarium pump installed in Unit-A provide filtered water in spawning tank with the help of PVC pipe fixed inside tank at an angle 45^0 for circular motion. Brooders injected with suitable inducing agents are released in Unit-B and spawning occurs after 5-6 hours and eggs get automatically transferred to Unit-C. Eggs are incubated in Unit-C and hatching occurs 16-18 hours after spawning. Before transferring to Unit-D, hatchlings are allowed to remains in Unit-C for an additional 48 hours. Transfer of hatchlings are carried out by closing the central outlet of Unit-C. Detail specifications of respective units are mentioned below. The complete hatchery units are installed in pond with help of bamboo poles.

Key features:

- Costs approximately Rs. 10,000.00
- Operates within ponds-First in-situ hatchery model
- Light weight, portable and dismountable
- In hot summer, water within hatchery component remains cool
- Possible to operate on a house hold battery-inverter system.
- Production capacity 0.06 million fry per cycle
- Suitable for small carp (Puti, Reba, Bata, Pengba etc.) of size less than 500 g
- Low electricity consumption (4 - 5 unit/ cycle)
- Water re-circulated back into the pond-minimal water loss

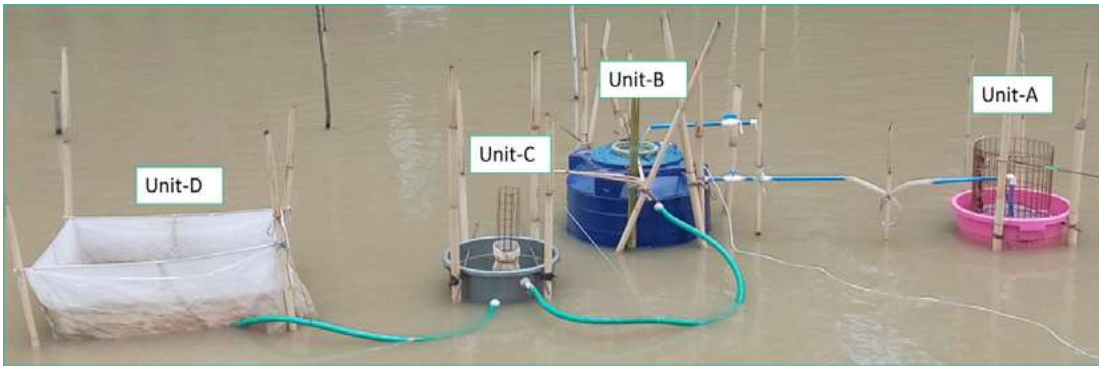

Fig. 1 Complete CAU (Imphal)-Brshti installed in pond: Unit-A: water filtration cum thermal regulation chamber; Unit-B: spawning tank; Unit-C: incubation tank; Unit-D: fry collection chamber

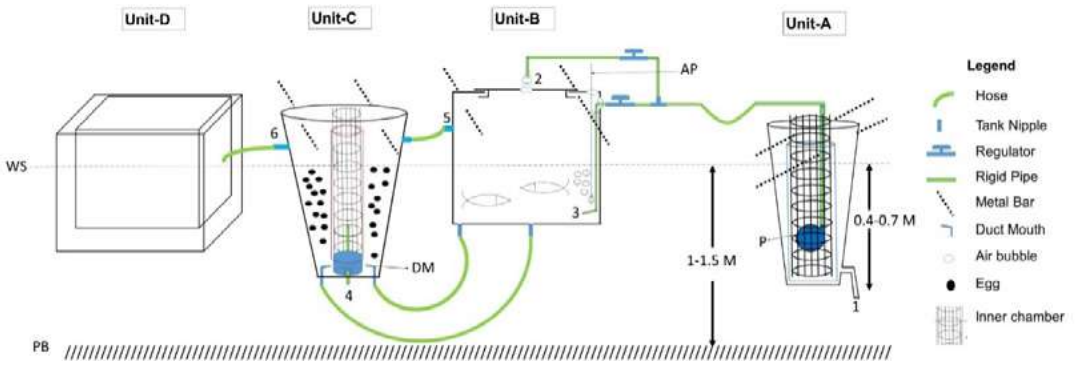

Fig. 2 Schematic diagram of the assembled CAU (Imphal)-*Brshti* : Notation are 1: rotatable water inlet; 2: shower; 3: spawning tank water inlet; 4: incubation tank central outlet; 5: overflow safety outlet; 6: fry releasing outlet; P: electric pump; AP: aeration pipe; DM: duck mouth; WS: water surface; PB: pond bottom

5. **Critical inputs required:**

- **Unit-A:** Water filtration cum thermal regulation chamber (double chambered, outer chamber: 100 litre bucket; inner chamber: iron grill of mess size 2.5 centimeter folded to a diameter of 35 centimeterand covered by plankton net; pump: submersible aquarium pump of capacity 20-35 watt installed inside inner chamber; rotatable water inlet: at bottom edge of bucket for entry of cool water in Unit-A)
- **Unit-B:** Spawning tank (Tank: 200-litre overhead water storage tank; shower and water inlet connected to pump with PVC pipe)
- **Unit-C:** Incubation tank (double chambered, outer chamber: 100-litre bucket; inner chamber: iron grill of mess size 2.5 centimeter folded to a diameter of 10 centimeter and covered by plankton net)
- **Unit-D:** Fry collection chamber (double chambered, inner chamber: cotton hapa of dimension 1 x 1 x 1 m^3; outer chamber: 1.1x1.1x1.1 m^3)
- **Pipe and fittings:** PVC pipe (0.5 inch), tank nipple (0.75 inch), bamboo, rope, flexible pipe (0.75 inch).

6. **Observations to be recorded:** Integration solar-battery inverter to evaluate its utility in electricity deficient region.

7. **Target users/stakeholders:** Multi Technology Testing Centers (MTTCs)/ KVKs/SHGs/NGOs/ Farmers

8. **Precaution(s) with the technology:** The hatchery design has several safety mechanisms to avoid any accidental overflow causing loss of egg & fry and require minimal human intervention. However, sometimes the following difficulties may arise

   - Clogging of connection pipe by faecal matter (in case of herbivorous fishes)
   - Clogging of inner chamber of incubation tank (in case large number of brooders used)

9. **Advantage/ Benefits/ Utility of technology:** Estimated cost: 10,000.00 (INR); Rate of return over investment: 87%.

10. **Economics of the technology/ Benefit: Cost Ratio:** Benefit cost ratio: 1: 2.48

11. **Technology developed under the project:** Centre of Excellence-Fisheries and Aquaculture Bio-technology funded by DBT, GOI, New Delhi.

12. **Investigator(s)/inventor(s):**

    H. Priyadarshi, R. Das, S. Prakash, A. A Singh, A. B. Patel and P. K. Pandey: Email: priyadarshimanshu@gmail.com; Mobile: 9862346943.

13. **Technology publication(s):**

    Priyadarshi, H., Das, R., Prakash, S., Singh, A. A., Patel, A. B. and Pandey, P. K. (2017). Fabrication and in-pond operation of a low-cost, semiautomated portable carp hatchery with a temperature-adjustability feature. *Journal of Applied Aquaculture*, **29**(3-4): 233-244.

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TECHNOLOGY:
NECTAR-AC-62

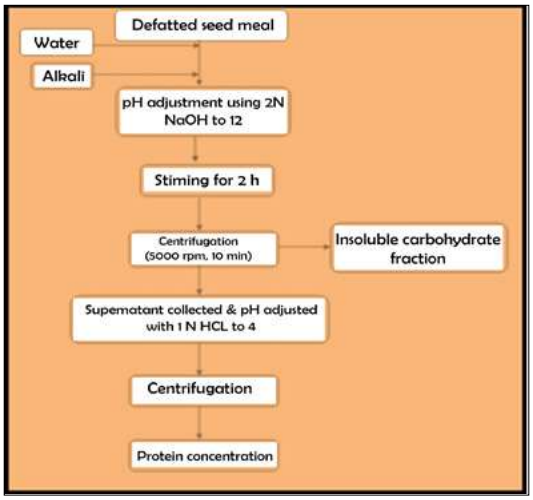
1. **Name of the technology:** Fish feed using protein concentrates and protein isolates from rubber seeds

2. **Source of the technology:** COF (CAU, Imphal), Tripura and ICAR-CIFE, Mumbai

3. **Year of adoption/development/ publication:** 2018

4. **Description of technology with salient features:**

   Rubber seed is an important by-product of rubber cultivation in many tropical countries. However, the yield of seed is largely wasted. Globally, India is the 2nd in productivity, 4th in production and consumption and 5th in area with 5,97,000 ha. From a hectare of plantation, 300-400 kg seeds are produced per year. Thus, on a rough estimation, approximately 2,38,800 MT of rubber seeds are produced annually in India. The kernel of rubber seed is roughly half of the weight of the total seed. The kernel contains 20% protein with 40-50% unsaturated oil. Thus, from India alone, 1,19,400 MT of kernel is produced every year. However, much of this valuable resource is unutilized and this untapped resource can be used for feeding aquatic animals after converting into suitable non-toxic form. The technology that has been developed to prepare protein concentrates (**Fig. 1**) as well as protein isolates (**Fig. 2**) from rubber seed kernel, which can be utilized as non-conventional protein feed ingredients in aquafeed is presented here. The tannins, phytate and HCN levels were found to be low in rubber protein concentrate compared to rubber seed cake while the content of trypsin inhibitor was nearly similar in both. It can be used for preparing fish feed and other livestock feeds. **The technology can also be upscaled to commercial levels.**



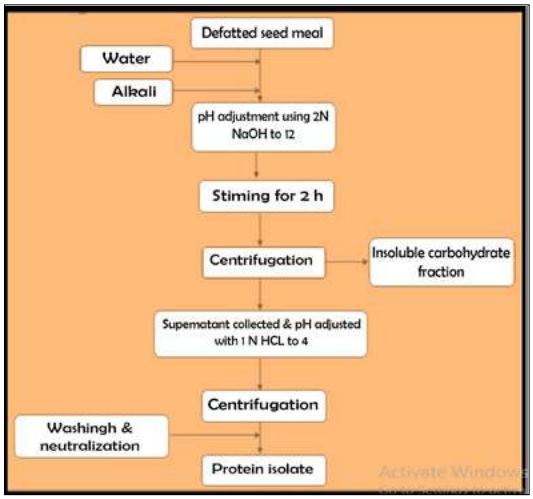


Fig. 1 Steps involved in concentrate preparation

Item	Dry matter recovery	Protein content
Protein concentrate	22.16 ± 0.40	69.86±3.11
Protein isolate	17.547 ± 0.13	90.8± 3.55

Table 1 Dry matter recovery (DMR) and protein contents of protein isolate and concentrate prepared from defatted rubber kernel meal and seed cake, respectively

Parameters	Protein concentrate	Protein isolate
Moisture	3.79± 0.86	2.11±0.08
Crude protein	69.86±3.11	90.8± 3.55
Crude lipid	1.98± 0.12	-
Ash	5.60± 0.58	1.11±0.11
Crude fibre	7.68± 1.02	3.03± 0.95
NFE	11.08± 0.95	3.06±0.98

Table 2 Proximate composition of protein concentrates and isolate

Fig. 1 Rubber seed and other forms

5. Critical inputs required:

Ingredients for the preparation of protein concentrate and isolates:	
• Rubber seed	• N Hexane
• HCl	• NaOH
Equipment required:	
• pH meter • Centrifuge	• Oil Extraction unit etc.
Other items: Fuel, labour, packing material	

6. Observation to be recorded:

• pH	• Crude Protein (%)
• Tannin (%)	• Phytate (mg g^{-1})
• HCN (mg kg^{-1})	• Trypsin Inhibitor (mg TI g^{-1})

7. **Target users/stakeholders:** Industry/ Consumers/SHGs/NGOs

8. **Precaution(s) with the technology:**

- Raw rubber seed should be stored in bulk as it is available only at particular seasons
- Storage of the seeds should be done after proper drying
- Dried seeds should be kept at dry places

9. **Advantage/Benefits/Utility of technology:**

- Can be used for preparing fish feed and other livestock feeds
- Rubber protein concentrate could completely replace soy protein concentrate in the fish feed.
- Rubber protein concentrate can be used up to 40% without having any detrimental effect.
- Non-conventional protein fish feed ingredient
- Reduced the cost of fish feed drastically

10. **Economics of the technology:**

Fixed cost		Working cost for producing 1 kg protein conc. in mass	
Particulars	**Cost (in lakh)**	**Particulars**	**Cost (in Rs)**
pH meter	1.00	Rubber Seed (approx. 5 kg)	20.00
Oil Extraction Unit	1.00	Chemicals (NaOH/HCl/nHexane etc.)	10.00
Centrifuge	1.00	Electricity	20.00
Laboratory	2.00	Labour	30.00
Store room	2.00	Miscellaneous	10.00
Weighing balance	0.25	**Total production cost** (Rs kg^{-1})*	**90.00**
Glassware	0.25	* In wholesale markets of India, the price of **soy protein isolate** price is around 200 kg^{-1}.	
Miscellaneous	1.00		
Total Fixed Cost	**8.50**		

Technology developed under the project: DBT, GOI, New Delhi funded twining project entitled "Utilization of Detoxified Rubber Seed Cake in Aqua Feed"(COF, (CAU, Imphal), Tripura and ICAR-CIFE, Mumbai)

12. **Investigator(s)/inventor(s):** H. Saha, R. K. Saha, N. P. Sahu and A. K. Pal: Email: sahacofcau@gmail.com/ ratankumarsaha123@gmail.com; Mobile: 9774325853; 9436122795

13. **Technology publication(s):**

Saha, R. K., Saha, H. Sahu, N. P. and Pal, A. K. (2017). Final Report "Utilization of Detoxified Rubber Seed Cake in Aqua Feed" submitted to the DBT, GOI, New Delhi.

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TECHNOLOGY:
NECTAR-AC-63

1. **Name of the technology:** Organic piscicides for killing weed fishes in aquaculture pond
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of adoption/development/ publication:** 2018
4. **Description of technology with salient features:**

Aquaculture is one of the most important progressive sectors but the presence of weed and predatory fishes in nursery and culture systems cause a serious problem for spawn, fry, and fingerling rearing and raising of table size fish. These fishes adversely affect the cultured fish population in culture ponds by sharing food and habitat of major cultivated carps. Hence, removal of predatory and weed fishes from the nursery and rearing ponds prior to their being stocking with the spawn of candidate species is an essential primary requisite step for the raising of fry and fingerlings. Until now, inorganic insecticides such as aldrin, dieldrin, endrin and endosulphan etc. were being used. But due to their long-term persistence in the water and fish body, they affect both the quality of fish and their status and also the health of consumers. A better alternative of these harmful inorganic piscicides will be plant-based product, which will be less expensive, biodegradable, and readily available, easy to handle and safe for both mankind and environment. Keeping above information in mind, a technology has been developed to use the extract from *Millettia pachycarpa* (Benth.) of NE region for killing weed fishes. An extract from the bark of *Millettia pachycarpa* (Benth.) has shown effective piscicidal activities against tested fish (*Oreochromis niloticus* and *Channa punctatus*). The lethal doses vary with fishes (**Table 1, 2**).

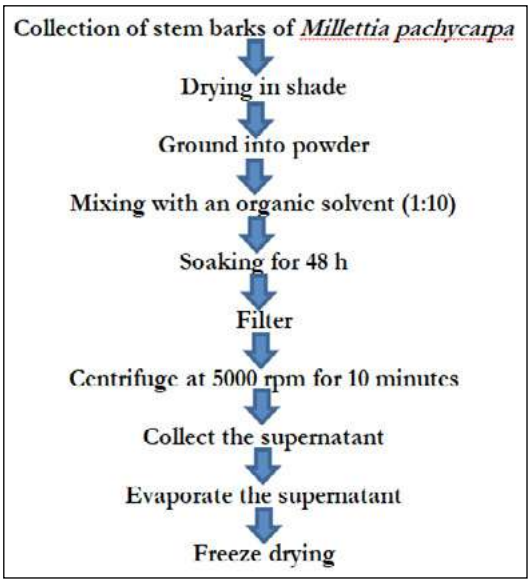

Fig. 1 Preparation of piscicides preparation in brief

Table 1 Comparison of various toxic factors during 24, 48, 72 and 96 h in *Oreochromis niloticus* (Output Taken from Biostat 2009 software)

Toxic factor	Time elapsed (h)			
	24 h	48 h	72 h	96 h
LC_{50} (Mean ± SE)	7.73± 0.55	6.81±0.53	6.32±0.58	6.15±0.66
Lower limit	5.84	5.00	4.31	3.89

Upper limit	9.62	8.62	8.41	8.33
Lethal Dose	13.12	11.98	12.04	12.59

Table 2 Comparison of various toxic factors during 24, 48, 72 and 96 h in *Channa punctatus* (Output taken from Biostat 2009 software)

Toxic factor	Time elapsed (h)			
	24 h	**48 h**	**72 h**	**96 h**
LC_{50} (Mean ± SE)	330.16± 9.73	318.47±9.50	313.27±8.00	306.25±9.25
Lower limit	296.45	284.96	285.06	273.64
Upper limit	363.88	351.99	341.48	338.87
Lethal Dose	410.15	386.11	370.19	372.08

Fig. 1 Stems of *Millettia pachycarpa* (Left) and Extract prepared from the bark of stems (Right)

5. Critical inputs required:

a) Ingredients for the preparation of medicated feed

- Stems of a local plant
- Organic Solvents
- Hot plate
- Grinder etc.

b) Equipment required:

- Evaporator
- Freeze dryer

c) Other items: Fuel, labour, packing material

6. Observation to be recorded:

- Growth rate
- Relative Percentage Survival

7. Target users/stakeholders: Industry/Consumers/SHGs/NGOs/KVKs/MTTCs

8. Precaution(s) with the technology: Identification and Collection of *Millettia pachycarpa* stems bark

9. Advantage/Benefits/Utility of technology: Salient advantages are:

- Organic piscicides
- No bioaccumulation
- Biodegradable
- No residual effect
- No biomagnifications

10. Economics of the technology:

Fixed cost		Working cost for producing 1 kg extract	
Particulars	**Cost (in lakh)**	**Particulars**	**Cost (in lakh)**
pH meter	1.00	Barks from the stems need to be collected	100.00
Oil Extraction Unit	1.00	Chemicals	100.00
Centrifuge	1.00	Electricity	20.00
Laboratory	2.00	Labour	30.00
Store room	2.00	Miscellaneous	10.00
Weighing balance	0.25	**Total Production cost kg^{-1}**	**280.00**
Glassware	0.25		
Evaporator	2.0		
Miscellaneous	1.0		
Total Fixed Cost	**10.5**		

11. Technology developed under the project: MFSc research work and thesis submitted to CAU, Imphal.

12. Investigator(s)/ inventor(s):

B. Chouriya, H. Saha and R. K. Saha: Email: sahacofcau@gmail.com / ratankumarsaha123@gmail.com; Mobile: 9774325853/9436122795.

13. Technology publication(s):

Chouriya, B. (2018). Evaluation of *Millettia pachycarpa* (Benth.) Plant Extract as a Piscicide against Weed Fish, 133 pp., MFSc Thesis submitted to Central Agricultural University (Imphal).

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Chapter - 6

FARM MACHINERY (FM) 42 technologies

TECHNOLOGY:
NECTAR-FM-64

1. **Name of the Technology:** Conversion of loose charcoal/ charcoal dust into usable fuel
2. **Source of the Technology:** CAEPHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of release/development/ adoption:** 2010
4. **Description of technology with salient features:**

The wood cutting from forest is a common practice in hills of the NEH region to meet the daily needs of fire wood. The forest cover is reduced every year because of this unchecked wood felling and gathering, a conservative estimate says that 1-2 tonnes of forest woods is stockpiled in every house backyard, which in itself indicates the amount of forest felling happening to meet the fuel requirements. This necessitated to innovate technologies to prevent this large-scale forest felling. The local woody biomass is first converted into charcoal using kiln. The small pieces of charcoal and charcoal dust are converted into usable briquettes. using the manual hand pressed and screw press that are described here.

Process: In the charcoal making process, small charcoal and charcoal dust is generated which is generally not used. In the present technology, this unusable charcoal is converted into briquettes. The fine charcoal dust is mixed with 10% to 20% of cow dung w/w basis and is converted into thick dough by mixing with water. The dough is pressed into briquettes using hand press or screw type press to extrude small rod-shaped briquettes (**Fig. 1 & 2**). In case such presses are not available, the dough is spread into hollow wooden frame (150 x 200 x 20 mm frames). Upon drying of these briquettes in bright sun, these can be used as smokeless fuel with higher calorific value. (**Fig. 3**)

Properties of briquettes: Volatile matter-14%, ash content- 15%, fixed carbon-71%, heat value, Kcal kg^{-1}- 4500

Benefit over traditional practice: The technology helps in converting otherwise unusable charcoal into usable fuel briquettes. This can also be used as income generation activity of households, as the briquettes generated have good market value.

Fig. 1 (a & b) Manual hand press and screw press machine for making briquetts

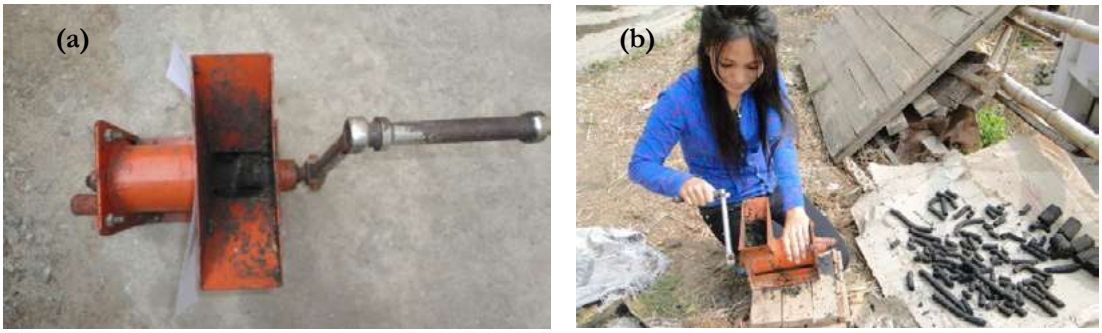

Fig. 2 (a & b) Manual screw pressing briquettes making machine

Fig. 3 (a & b) Dried handmade briquettes for sale/use & burning of briquettes in stove for cooking

5. **Critical inputs required:** Cow dung, water for making charcoal dough.

6. **Observation to be recorded:** Moisture content of charcoal &cow dung mixture, binding, pressure, feeding rate, output rate, Briquettes wet& dry moisture content.

7. **Target users/stockholders:** Farmers, Farm women's, small scale entrepreneurs, KVKs/SHGs

8. **Precautions with the technology:** Moisture content of wet mixture, solar intensity for drying

9. **Advantage/Benefits/Utility of technology or product:** The briquettes for homemade utilization of biomass and charcoal dust. Low cost smokeless fuel, value addition and income generation.

10. **Economics of technology/cost benefit ratio:** 1:1.5

11. **Technology developed under the project:** ICAR-AICRP-RES

12. **Investigator(s)/ inventor(s):** A. K. Mishra and P. K. Srivastava: Mobile No.: 9826328767/ 8319609685; Email: akm.caepht@gmail.com

13. **Technology publication(s):**

Annon. (2011). Demonstrated in awareness training programmes under RES Renewable energy gadgets for NE Region, pp: 48-51, Compadium, Promotion of improved agricultural equipments and technology in NEH region, 22-25 November, 2011.

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1. Dean, College of Agricultural Engineering and Post-Harvest Technology (CAU, Imphal), Ranipool, Gangtok- 737 135, Sikkim. Email: dean.caepht@gmail.com; dean-caepht@gov.in.
2. Dr. A. K. Mishra, Deputy Director Research, CAU, Imphal; email: akm.caepht@gmail.com

TECHNOLOGY:
NECTAR-FM-65

1. **Name of the technology:** Animal drawn wing plough
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development**: 2011
4. **Description of technology with salient features:** The traditional plough of Sikkim is made of wood, heavy in weight and needs high power to pull. The life of the plough is 1 – 2 years only. Keeping in view these drawbacks, an iron made two wings plough, which was available in other region, was modified with respect to size (**Fig. 1**) based on the pulling capacity of bullocks available in Sikkim. It is suitable for both friable and wet ploughing and is an appropriate replacement of traditional wooden plough. Since, it is made of mild steel, and life of the wing plough is about 4-5 years. The plough has been tested in the farmer's field (**Fig. 2**) and the performance of plough has satisfactorily improved over traditional plough. After field test, following observations were recorded.

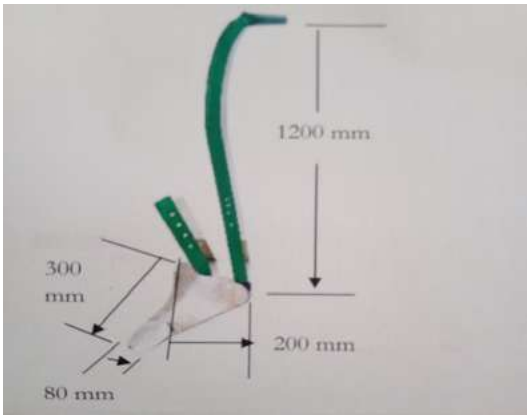

Fig. 1 Dimensional details of wing plough

Fig. 2 The wing plough being demonstrated on farmer's field

Specification: It is made of steel having 200 mm working width and weighing about 5.5 kg without beam. Share tip width: is 80 mm, length is 300 mm and handle height: is1200 mm

Field test:

- The draft requirement is 40 kg against 45 kg of traditional plough. Work rate: 0.03 ha h^{-1} as compared to 0.02 ha h^{-1} of traditional plough
- Higher work rate may be due to reduced draft and time lost in turning
- Cost: Rs. 1000.00, Operating cost: Rs. 2500 ha^{-1}, Saving over tradition plough: 35%.
- The average clod size developed by using wing plough was 110.0 mm as compared to 176.0 in case of traditional plough. The depth of ploughing was 100 mm. Therefore, work quality is better than traditional plough

- About 30 h is required to plough one ha area.

5. **Critical inputs/ equipment/ items required:**

- A pair of bullock
- One operator

6. **Observation to be recorded:**

- Depth of ploughing
- Quality of work (pulverization)
- Work rate

7. **Target users/stakeholders:** MTTCs/ KVKs/Farmers

8. **Precaution(s) with the technology**: Same as ploughing with traditional plough

9. **Advantage/Benefits/Utility of the technology:**

   Higher service life as made of steel, light in weight, higher work rate, better quality work and cheaper in cost.

10. **Economics of the technology/ Benefit: Cost Ratio:** 35% economical over traditional plough, Cost Rs 1000.00 as compared to Rs 1500.00 of traditional plough

11. **Technology developed under the project:** Departmental R & D activity

12. **Investigator(s)/ inventor(s):** S. N. Yadav, Email: snyadavbpl@yahoo.com; Mobile: 9933469544.

13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 02: Technology No. 44: Wing plough,79 p.

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TECHNOLOGY:
NECTAR-FM-66

1. **Name of the technology:** Animal drawn single row zero till drill
2. **Year of adoption/development:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of release:** 2011
4. **Description of technology with salient features**:

For sowing of *Rabi* crops, traditionally two ploughing with indigenous plough and two plankings for land preparation and sowing behind plough are practiced. The animal drawn single row zero-till drill is suitable for seeding in single pass at residual moisture content of soil (22% dry basis) and advantageous in terms of timeliness and saving in cost of operation compared to the traditional practice. It consists of seed box, main frame, two ground wheels, handle and clevis for fitting beam and chain sprocket arrangements for transmitting power to seed feed shaft. Following are the details about the developed farm implement (**Fig. 1**)

Specification

- Overall dimension, mm : 700 x 460 x700
- Weight, kg : 20
- Unit price(with all attachments), Rs. : 3000/-

Function: Sowing of *rabi* crops after just after harvest of *kharif* crops without preparatory tillage.

Performance

- Effective field capacity, ha h^{-1} : 0.034
- Cost of operation, Rs ha^{-1} : 1470/-

Benefits

- Saving in time, % : 65
- Saving in cost, % : 70
- Suitability : All states of NEH Region.

Table 1 Field test trials of animal drawn single row zero till seed drill for sowing of Buckwheat seeds

Sl. No.	Parameters	Values	
		Trial I	Trial II
1.	Area of the terraces, sq. m	69.43	68.04
2.	Size of terrace, m (l x b)	26.5x2.62	27x2.52
3.	Total duration, min	12	08
4.	Height of stubbles, mm	112.5	105
5.	Soil moisture (db) %	22.3	22.5
6.	Working width, mm	370	370
7.	Average depth of sowing, mm	48	54
8.	Speed of bullock, km h^{-1}	2.47	2.42
9.	Draft of machine, N	437	432
10.	Effective field capacity, ha h^{-1}	0.0350	0.033
11.	Field efficiency, %	52.5	50.87
12.	Cost of operation, Rs ha^{-1}	1428	1515

5. Critical inputs required:

• Seed	• Zero till drill
• Animal: One pair of draught animal	• Labour/Operator (nos.): one

6. Observation to be recorded:

• Area of terraces, m^2	• Height of stubbles, mm
• Number of stubbles per m^2	• Soil moisture content (db %)
• Operating Speed (km h^{-1})	• Row to row spacing (mm)
• Seed Rate (kg ha^{-1})	• Depth of sowing (mm)
• Actual field capacity (ha h^{-1})	• Theoretical field capacity (ha h^{-1})
• Field efficiency (%)	• Draft, N

Fig. 1 Single row zero till drill in operation on farmers (Mr. Roop Narayan Bhattarai, Village: Samlik Marchak East Sikkim) field

7. Target users/stakeholders:

MTTCs/ KVKs/ Farmers/Companies/ innovators

8. Precaution(s) with the technology:

Machine should be properly calibrated as per requirement before going to sowing in farmers field. Never use planker/ leveller after sowing of seed by the zero till seed drill.

9. Advantage/Benefits/Utility of the technology:

The zero tillage seeding in single pass at residual moisture content of soil (22% dry basis) with cost of operation Rs m^{-2} = 0.15 compared to the traditional practice of preparatory tillage-sowing after rice harvest was found to be advantageous in terms of timeliness and 78% saving in cost of operation compared to the traditional practice [Traditional ploughing by indigenous plough, one pass, Rsm^{-2} = 0.33/- and two passes of clod crusher cum leveller, Rs m^{-2} = 0.17].

10. Economics of the technology/ Benefit: Cost Ratio:1: 3.33

11. Technology developed under the project:

ICAR-AICRP on UAE Centre of CAEPHT (CAU), Gangtok, Sikkim.

12. Investigator(s)/inventor(s):

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13. Technology publication:

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 02: Technology No. 56: Animal drawn single row zero till drill: 94 – 95.

Tiwari, R. K. and Chauhan, S. K. (2016). Animal drawn improved sowing equipments for mustard in terraces of Sikkim in India. *Agricultural Mechanization in Asia, Africa, and Latin America*, **47**(4): 82-86. (ISSN:00845841, 9 H Index).

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TECHNOLOGY:
NECTAR-FM-67

1. **Name of the technology:** Improved large cardamom harvesting knife
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of release/ adoption:** 2011
4. **Description of technology with salient features:**Harvesting of Large cardamom requires special skill. The worker has to apply force to detach the spike from the shoot, remove the unproductive pseudo stem from the bush to provide adequate space for new shoot and avoid cutting of the tillers that may bear fruit in future. The matured spikes are cut with the help of traditional knife locally known as "*Elliachi Chhuri*" It is made of mild steel generally from structural steel and gets blunt after use of 30-50 hours.Mainly four varieties of large cardamom namely *Bharlong, Ramsai, Sauni* and *Seremna* are grown in the Sikkim. Bush characteristics, plant height, shoot location and force requirement for these varieties vary and farmers use different shape and size of knives as per the varieties (**Fig. 1**). Keeping in view of above, four designs of improved large cardamom harvesting knives (**Fig. 2**) have been developed.The existing traditional knife was design refined for length, width, curvature, sharp/ serrated edge of the blade with substitution of high carbon steel material (EN8). The handle grip material was replaced to plastic material in place of wood for more positive grip and to make it light weight further.

Fig. 1 Four types of traditional cardamom harvesting knives

Fig. 2 Four types of improved cardamom harvesting knives

Both traditional and improved large cardamom harvesting knives were evaluated to compare the energy requirement and drudgery reduction. The oxygen consumption (VO_2), Energy Equivalent (EE), Heart Rate (HR), oxygen consumption/heart beat (VO_2/HR) were measured. Initially, VO_2 was 22.6^{-2} and 17.6-ml min^{-1} kg^{-1}for traditional and improved knives, respectively. The average HR was 129 and 1122.5 bpm for traditional and improved knives respectively. It was found that the energy expenditure in general was lesser and oxygen consumption per kg body weight of the subjects was initially lesser for improved knife compared to the traditional knife. Lesser energy requirement and heart rate while using these improved knives have indicated comfort to the worker as compared to his working with the traditional knives. The average work rate (kg h^{-1}) was 5.8 and 8.08 for traditional and improved knives respectively. The increase in work rate was about 39%.

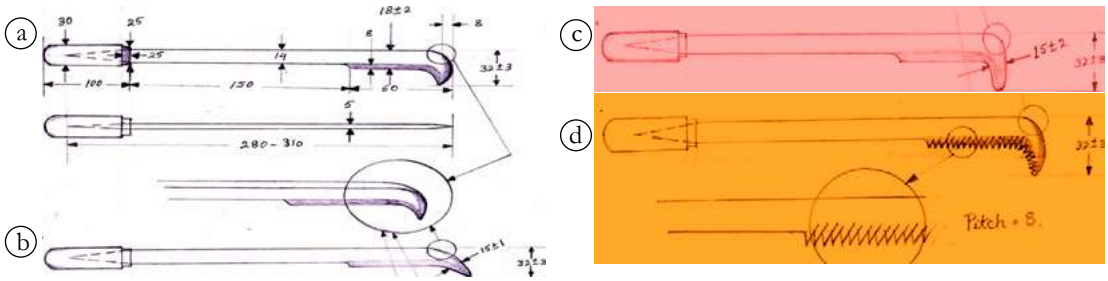

Fig. 3 (a,b,c,d) Shapes, sizes and blade curvatures of different types of cardamom harvesting knives

Fig. 4 Improved large cardamom harvesting knife being used for harvesting

Specification: The size and shape of the improved knives, as shown in **Fig. 3**, varies as mentioned below: *weight: 180 – 220 g, * blade thickness: 08-10mm, * length: 150 to 310 mm. Fig.4 shows the use of developed large cardamom knife..

5. **Critical inputs required:** Knifes and labour

6. **Observation to be recorded:** Work rate and ergonomic evaluation

7. **Target users/stakeholders:** MTTCs/ KVKs/Farmers

   Precaution(s) with the technology: As in case of traditional cardamom harvesting knife. The edges are very sharp hence requires attention while in use.

9. **Advantage/Benefits/Utility of the technology:** Increased life (from 2 to 5 years), higher work rate by about 39%, reduced drudgery etc.

10. **Economics of the technology/ Benefit: Cost Ratio:**Unit price: Rs 150.00 (year 2011)

11. **Technology developed under the project:** AICRP on ESA Centre of CAEPHT, Ranipool, Sikkim

12. **Investigator(s)/inventor(s):** T. K. Khura, M. S. Seveda, S. N. Yadav and S. K. Rautaray: Email: snyadavbpl@yahoo.com; Mobile: 9933469544

13. **Technology publication:**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 02: Technology No. 58: Improved large cardamom harvesting knife, 96 - 97.

Folder on "Improved large cardamom harvesting knife" published by Dean, CAEPHT, Ranipool, October, 2014.

Contact address: Dean, College of Agricultural Engineering and Post Harvest Technology (CAU, Imphal), Ranipool, Gangtok- 737 135,Sikkim; Email:dean.caepht@gmail.com; dean-caepht@gov.in.

TECHNOLOGY:
NECTAR-FM-68

1. **Name of the Technology:** Multipurpose biomass grill for roasting fresh maize cobs and other vegetables

2. **Source of the Technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkm

3. **Year of release/ development/ adoption:** 2011

4. **Description of technology with salient features:** The developed device is an innovative prototype of improved stove suitable for cooking of meal, boiling water and roasting of freshly harvested maize cobs and other vegetables. It is designed with an objective of increasing the roasting efficiency of maize cobs per unit fuel. The stove was provided with specially designed central port for roasting fresh maize cobs which is more economical than the conventional practices (**Fig. 1**) with open roasting on mesh with fuel woods/ charcoal. This stove is 22-25% more efficient than the conventional methods and suitable for daily cooking with less fuel. The burning of wood charcoal/ fuel wood gives high thermal efficiency of 28-30%.

The unit consumes 1.0 kg wood charcoal to roast 25-30 cobs per hour. The improved stove (grill) is more economical than the conventional method as it is 22-25% more efficient than the conventional one. Stove (grill) using wood charcoal, briquettes and small wood chips require smaller storage space and deliver better performance. The benefit cost ratio for improved stove is 1: 1.47 with increase of 26% profit on sale of maize cobs for the income generation. This grill can also be used for grilling of other vegetables like brinjal, sweet potato, potatoes and meat products.

Design of the improved *sigri* (grill)

1. It consists of a rectangular box made of mild steel sheet of 5 mm thickness and has the following other parts.

a) A movable bio-mass tray (with wood handle).

b) A manual operated blower.

c) A movable ash tray.

d) Air control valve.

e) Insulation with (clay/soil).

Fig. 1 & 2 Roasting of green maize cobs in improved stove/grill

Specifications:

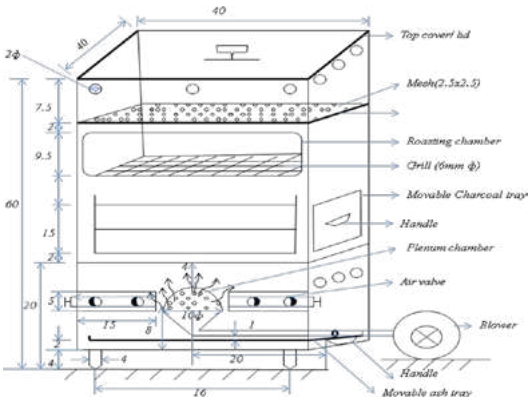

Fig. 3 Modified design for the improved biomass Stove (grill)

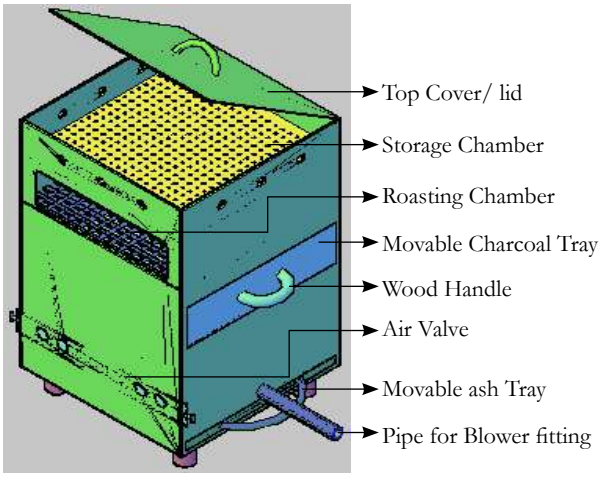

Fig. 4 CAD design of Energy Efficient Improved Bio-mass Stove (grill)

Table 1 Comparative performance of improved stove (grill)

Parameter	Traditional Practices	Improved Stove (Grill)	
	Fire wood	Wood- charcoal	Briquette
Roasting cost per cob, Rs.	0.85	0.27	0.30
Fuel used per cob, g	28	28	63
Cost of green cob, Rs. (150 Nos.)	750	750	750
Fuel cost, Rs. (150 Nos.)	300	120	90
Input cost per day (150 cob), Rs.	1050	870	840
Profit per day, Rs.	450	630	660
Net profit per month, Rs.	13500	18900	19800
Calorific value, kcal kg^{-1}	2950	6930	3266
Thermal efficiency, % (Average)	08-10	20-23	18-21
Fuel consume per month, kg	1800	360	540

5. **Critical inputs required:** Fuel-charcoal/ wood/briquetts,

6. **Observation to be recorded:**

   Number of maize cobs roasted per unit time and fuel consumption per unit time. Usability for different purposes like roasting of vegetables, cooking of food, and for roasting of meat products.

7. **Target users/stockholders:** Farmers/ rural peoples/MTTCs/KVKs

8. **Precaution(s) with the technology:** Avoid direct contact with stove to prevent burn.

9. **Advantage/ Benefits/ Utility of technology or product:** Simple in design, suitable to roast more cobs at a time, less fuel consumption.

Fig. 5 Shows the transport of maize cobs for sale

Fig. 6 Traditional practice for roasting maize cobs

Fig. 7 Roasting of green maize cobs in improved stove (grill)

10. Economics of technology/benefit cost ratio: 1:1.5

11. Technology developed under the project: ICAR-AICRP-RES

12. Investigator(s)/inventor(s): A. K. Mishra and P. K. Srivastava: Mobile No.: 9826328767/ 8319609685; email: akm.caepht@gmail.com

13. Technology publication(s):

Mishra, A. K. and Srivastava, P. K. (2012). Improved energy efficient biomass Stove (Grill) for roasting green maize cobs for income generation in Sikkim and NEH region, *CAU Research Newsletter*, 3(2): 3-4. (ISSN 2319-3042).

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TECHNOLOGY:
NECTAR-FM-69

1. **Name of the Technology:** Twin fixed dome biogas plant for cold hilly terrain of NEH
2. **Source of the Technology:** CAEPHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of release/ development/ adoption:** 2011
4. **Description of technology with salient features:**

Biogas is produced due to microbiological fermentation of organic residues and by-products. The raw material utilized can be animal dung, vegetable and kitchen residues etc. The biogas thus produced can be used for cooking purposes or power generation and the digested slurry being a rich source of nutrients and can be used as soil amendment to enrich the soil. While several models of the biogas plant are available, the present technology consists of two fixed dome structures made in series at different elevations to improve efficiency and also to save space in undulating heights of NEH region.

The design consists of two underground biogas gas plants connected in line in series and at different elevations. The first plant is at higher elevation and is fed with fresh cow dung mixed with equal amount of water and next plant which is at a lower elevation is fed with slurry coming out from first biogas plant to yield more gas per unit fresh cow dung. The digested slurry coming out from second plant was spread in open field to absorb excess water in soil and semi dry manure collected for farm/vermicompost use. Both the digesters are connected with gas pipe for the use of biogas in kitchen.

This type of biogas plant is most suitable for Meghalaya, Manipur, Tripura and Arunachal Pradesh having warm climate compared to Sikkim, Mizoram, Nagaland. Such an adaptation is expected to ideal for the cold climate of hills as it is covered on the top which retains the heat of cement and concreate with the pit being made into the ground.

Fig. 1 & 2 Twin fixed dome biogas plant connected in series for enhance biogas production in cold climate of hills


Fig. 3 & 4 Twin biogas plant in series at elevation and digested Slurry for manure

5. **Critical inputs required:** Cow dung, water. hot water is required if the ambient temperature is low for slurry making. **Observation to be recorded:** Ambient temperature, dung: water ratio, retention time, daily bio gas production, TSS check

6. **Target users/stockholders:** Farmers, SHGs, Hotels, Schools for mid-day meal

7. **Precaution(s) with the technology:** Proper covering of the dome, and sealing of inlets with insulating material like soil, gunny bags etc is required to maintain the digester temperature. regular and timely feeding with cow dung should be carried out, cracking of scum formation inside the plant at regular intervals is recommended.

8. **Advantage/ Benefits/ Utility of technology or product:** The gas recovery per unit of cow dung is higher in this design, further such design is useful in sloppy terrain and is space saving.

9. **Economics of technology/ cost: benefit ratio:** 1:1.5

11. **Technology developed under the project:** ICAR-AICRP-RES

12. **Investigator(s)/ inventor(s):** A. K. Mishra and P. K. Srivastava: Mobile No.: 9826328767/8319609685; email: akm.caepht@gmail.com

13. **Technology publication(s):**

Highlights of AICRP ON RES, CIAE, Bhopal, Salient Accomplishments, S. No.2, Performance evaluation of himshakti biogas plant for hilly terrain on Sikkim, Project Code-CAEPHT/ RES/ BCT/2009/1.

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2. Dr. A. K. Mishra, Deputy Director Research, CAU, Imphal; email: akm.caepht@gmail.com

TECHNOLOGY:
NECTAR-FM-70

1. **Name of the Technology:** Improved multipurpose *sigri*/stove
2. **Source of the Technology:** CAEPHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of release /development/ adoption:** 2012
4. **Description of technology with salient features:**

An innovative prototype of improved stove suitable for cooking of food, boiling water and roasting of freshly harvested maize cobs and other is designed with an objective of increasing the roasting efficiency of maize cobs per unit fuel. The stove is provided with specially designed central port for roasting fresh maize cobs which is more economical than the conventional practices with open roasting on mesh with fuel woods/charcoal. This stove is 22-25% more efficient than the conventional methods and suitable for daily cooking with less fuel. The unit consumes 0.2 to 0.5 kg wood charcoal/briquettes to roast 10-20 cobs per hour. It has 240 mm diameter and 340 mm height. The diameter of internal roasting chamber is 100 mm. Total weight of *sigri* is 4.5 kg' that is provided with 40 mm ground clearance for air intake to burn fuel efficiently. The burning of wood charcoal/ fuel wood gives high thermal efficiency of 28-30%. The operating cost is Rs. 10-20 h (wood chips, wood charcoal, briquettes in unit/mixed) with emission of CO-8-12 g with particulate matter as 65-85 mg for cooking of 2.5 l of food.

Multipurpose stove using wood charcoal, briquettes and small wood chips require smaller storage space and deliver better performance. The cost benefit ratio for improved stove is 1.47 times with increase of 40% profit on sale of maize cobs for the income generation. This is having simple design and can be fabricated by local artisans for income generation to the maize vendors and for home cooking. The multipurpose light weight stove is suitable for roasting of many other food items such

Fig. 1 Use of improved maize cob device for roasting on road side at Sikkim

as brinjal, potatoes, sweet potatoes, tomato, fish, chicken piece, *seek kabab* etc. **Fig. 1 & 2** showing the use of this small and useful cooking device on road side in Sikkim

Benefits over traditional practice:

The roasting of 10-20 nos. of green cob in improved stove (**Fig. 3**) saves 2.0 kg of fuel wood, 1.0 kg of wood charcoal compared to traditional practices. Besides it can be also used for cooking food (**Fig. 4**) with further saving in expenditure on domestic fuel The increase in profit after sale of roasted cob @ Rs. 100-400/d is to pay benefits to farmer as Rs 10000 month^{-1}. The cost of roasted cobs was Rs. 0.10 per cob using home-made briquettes prepared

Fig. 2 Multipurpose *sigri*/stove for daily cooking and roasting fresh maize cobs

Fig. 3 Cooking meal in multipurpose stove/sigri

Fig. 4 Wood handle with metal rod for roasting fresh maize cobs

from wood charcoal left over after use as by product of traditional *chulha* in rural areas. The cost benefit ratio of improved stove was 1.47 times with increase of 40% profit on sale of roasted maize cobs for the income generation. The handle rovided in stove for its handling (**Fig. 5**) is an added advantage.

5. **Critical inputs required:** Maize cobs, metal rod with wood handle for maize roasting, fuel-charcoal/wood/briquettes, manpower-one

6. **Observation to be recorded:** Fuel consumption per hour for cooking, water boiling test for thermal efficiency of stove, number of maize cob roasting and roasting of many other items as brinjal, potatoes, sweet potatoes, tomato and other like fish, chicken piece, seek *kabab* etc., heat loss, stove efficiency, saving of fuel.

7. **Target users/stockholders:** Farmers, farm women, unemployed youths and others

8. **Precaution(s) with the technology:** Avoid to touch the stove surface.

9. **Advantage/ Benefits/ Utility of technology or product:** Simple in design, suitable to roast more cobs at a time, lesser fuel consumption, simple design to fabricate by local artisans for income generation

10. **Economics of technology/ cost benefit ratio:** 1:1.47

11. **Technology developed under the project:** ICAR-AICRP-RES

12. **Investigator(s)/inventor(s):** A. K. Mishra and P. K. Srivastava: Mobile No.: 9826328767/ 8319609685; email: akm.caepht@gmail.com

13. **Technology publication(s):**

Mishra, A. K. (2014). Navikardiya urja upyog hetu urja daksh kum lagat ke yantra (Hindi article), pp:161-164,

Paper presented in Hindi seminar held at CIAE, Bhopal 28 July.

The Daily Encounter Sikkim 28 February 2011, CAEPHT Centre demonstrate improved cook stoves in farmers house,

Hamro Prajashakti Daily 24 May 2011, Awareness programme on biogas plant and improved stoves.

Sikkim Express News, 24 May 2011, CAEPHT Conducts awareness programme on RES

Himalayan Mirror Daily Newspaper 23 May 2011, CAEPHT Introduces Biogas plant in rural area as alternative fuel.

Demonstrated at CAU Agri -fairs and state level fairs during 2011-2014.

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TECHNOLOGY:
NECTAR-FM-71

1. **Name of the Technology:** Insulated biogas plant suitable for cold climate of Sikkim
2. **Source of the Technology:** CAEPHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of release/ development/ adoption:** 2012
4. **Description of technology with salient features:**

The hills of NE zone are cool at night hence the digesting efficiency of the traditional or existing biogas plants is low. To maintain the plant digester temperature even during cold periods, the present insulated design is proposed.

Twin walled digester tank of 3 m^3 is constructed. The space between the walls is filled with thermocole sheets in twin layers. Specifications of the thermocole used are given in **Table 1**. Thermocole helps in maintaining the heat in the digester for microbial digestion. The temperature measurements have shown that the internal temperature of 30-35 ^{0}C is maintained with this technology.

The plant (**Fig. 1**) is also covered by bamboo mat or poly sheet during night to conserve the heat absorbed in day time. With this insulation, the results showed that the biogas produced remained in the range of 1.69 m^3 - 2.4 m^3 throughout the year. The metallic gas holder floating over slurry is rotated once in a day to break scum formation in the plant. The inlet and outlet of the plant is plugged by gunny bag to prevent heat loss from digester.

Fig. 1 Insulated biogas plant at CAEPHT, Sikkim

The design details are given below:

Biogas production rate	: 1 m^3 20 kg^{-1} fresh manure
Retention Time of slurry	: 50 days
Dung : slurry ratio	: 1:1
Plant capacity	: 3 m^3
Daily requirement of fresh dung	: 60 kg
Daily requirement of water	: 60 kg
Daily input slurry requirement	: 120 kg
Capacity of digester	: 50 x 120 = 6000 l
Capacity of digester with 10% freeboard	: 6600 l
Height of the plant (H)	: 1 m

Diameter to depth ration of digester	: 1:1
Diameter of digester	: $\pi/4\ D^2 \times H$ =6600 x 1000 =2.05 m
Depth of digester	: 2.05 m
Annular space between digester and gas holder	: 100 mm both side
Capacity of gas holder	: 60% of plant capacity= 1.8 m^3

Diameter of gas holder	: 2.05 m - 0.2 m (annular space) = 1.85 m
Height of gas holder	: $\pi/4\ 1.85^2 \times H$ = 1.8 m^3 = 0.67 m

The floating gas holding tank was made with metal as shown in **Fig. 4**. The properties for insulating material are given in **Table 1**.

Table 1 Properties of thermocole used as an insulating material

S. No.	Particulars	Thermocole
1	Specific heat (kcal kg^{-1} ^0C)	0.27
2	Thermal diffusivity (m^2 h^{-1})	1.83
3	Thermal conductivity (W m^{-1} K)	0.028 to 0.033
4	Tensile strength (kg cm^{-2})	4.93

The provision of 100 mm thick thermocole insulation was able to reduce the flow of heat from slurry to soil in the temperature during the time cycle of 32 h, when the ambient temperature varied between 8°C to 19°C. Heat loss per unit surface area of digester was found to be 39.6 kcal and 113.9 kcal and heat loss per unit surface area of gas holder was found to be 93.8 kcal and 384.4 kcal, for insulated and fixed dome having no insulation respectively. **Fig. 2-4** present some details of the use of biogas plant.

Fig. 2 Placement of insulation sheet at annular space of digester outer wall to retain digester heat

Fig. 3 Gas holder frame to rest metal dome

Fig. 4 Metal floating biogas holder for storage of biogas

The yearly cumulative biogas production from insulated biogas plant was equivalents to 142.5 kg of LPG gas, that saves 10 LPG cylinders of 14.3 kg y^{-1}. The payback period for insulated plant was one and half year with LPG savings for 10 years without any additional maintenance cost to the farmer for cooking and lighting.

5. **Critical inputs required:** Cow dung, water, bucket, Labour-one
6. **Observation to be recorded:** Ambient temperature, cow dung: water ratio, Hydraulic retention time (40-50 days), daily gas production, slurry temperature, TSS of dung & slurry

7. **Target users/stockholders:** Farmers, hotels and other

8. **Precaution(s) with the technology:** Temperature maintenance is critical, if required, addition of hot water mixed with dung is recommended.

9. **Advantage/ Benefits/ Utility of technology or product:** This technology assures biogas production even in low temperatures.

10. **Economics of technology/ cost: benefit ratio:** 1:1.5

11. **Technology developed under the project**: ICAR-AICRP-RES

12. **Investigator(s)/inventor(s):** A. K. Mishra and P. K. Srivastava: Mobile No.: 9826328767/ 8319609685; email: akm.caepht@gmail.com

13. **Technology publication:**

Mishra, A. K. and Srivastava, P. K. (2012). Design, development and Performance of insulated biogas plant under cold climate of Sikkim, *CAU Research Newsletter*, **3**(2): 14-16. (ISSN 2319-3042)

Highlights of AICRP ON RES, CIAE, Bhopal, Salient Accomplishments, S. No.1, Performance evaluation of Insulated biogas plant for hilly terrain in Sikkim, project code-CAEPHT/ RES/BCT/2009/2.

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TECHNOLOGY:
NECTAR-FM-72

1. **Name of the Technology:** Portable kiln for making charcoal from biomass
2. **Source of the Technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of development/adoption:** 2012
4. **Description of technology with salient features:**

The wood cutting from forest is a common practice in hills of the NEH region to meet the daily needs of fire wood. The forest cover is reduced every year because of this unchecked wood felling and gathering. A conservative estimate says that 1-2 tonnes of forest woods is stockpiled in every house backyard, which in itself indicates the amount of forest felling happening to meet the fuel requirements. This necessitated to innovate technologies to prevent this large-scale forest felling. The present technology is one such alternative developed for the conversion of loose biomass like woody grasses, unwanted weeds and small shrubs like *Lantana camara* etc. in to charcoal.

Function: It converts loose biomass and crop residues into char by pyrolysis which can be later briquetted for use as smokeless fuel.

Performance: The portable metallic kiln **(Fig. 1)** converts sun dried loose biomass and crop residues into char at 300^{0}C temperature giving 25-60% good quality charcoal by pyrolysis for production of smokeless briquetted fuel. It consists of a mild steel drum, handle and door.

Benefits over traditional practice: Charcoal making from pyrolysis process under oxygen free burning in metallic kiln retains high fixed carbon (71%) and low ash content (15%), very little moisture (1-5%) and high yield (50-60%) over traditional earthen covered method (30%) commonly practices in Meghalaya and other states in NEH Region.

Specification: The kiln is a rectangular box made with mild steel sheet of 5 mm thickness with a movable lid which makes the box nearly airtight. The approximate weight of the kiln is around 20 kg. Input capacity of crop residues is around 20-30 kg in one filling with a charcoal output of 8.0 to 10 kg. Functioning: The kiln is first filled with 5-10 kg of biomass and ignited and immediately closed with the lid. After about 30% burning, the kiln is refilled with 5-10 kg of biomass and completely closed for pyrolysis. After 5 to 6 hrs, the stage of pyrolysis is checked. If needed, the biomass is stirred and kiln is again closed for completion of the pyrolisis process. The kiln is opened when the pyrolysis is complete and is cooled to ambient temperature. The charcoal thus formed is removed and separated into large and small pieces for convenience. The kiln is ready for reuse.

Fig. 1 Metal Kiln for charcoal making (the raw biomass and converted charcoal are put side by side in the lower picture for comparison of pyrolysis)

Fig. 2 Bio char after burning of loose biomass and briquettes for smokeless fuel

5. **Critical inputs required:** Dry loose biomass, wood pieces,

6. **Observation to be recorded:** Biomass moisture content, weight of biomass charged, weight of charcoal recovery, size of biomass, size of charcoal, burning time in oxygen less environments,

7. **Target users/stockholders:** MTTCs/ KVKs/Farmers/ small scale industries

8. **Precaution(s) with the technology:** kiln operation should be done in open place. Avoid one time and overfilling of biomass. Burning and turning of biomass at intervals to avoid over burning, avoid direct contact of metal surface, Use of fire proof gloves is recommended.

9. **Advantage/ Benefits/ Utility of technology or product:**

   The portable kiln is suitable for conversion of loose dry biomass and small wood pieces into smokeless fuel as wood charcoal. the charcoal dust can mix with cow dung for making briquettes thus increasing the efficiency of biomass. unusable charcoal dust can be used as soil amendment to improve the texture of soil for better root growth.

10. **Economics of technology cost/benefit ratio:** 1 : 2

11. **Technology developed under the project:** ICAR-AICRP on RES

12. **Investigator(s)/inventor(s):** A. K. Mishra and P. K. Srivastava: Mobile No.: 9826328767/ 8319609685; email: akm.caepht@gmail.com.

13. **Technology publication(s):**

    Demonstrated in awareness training programms under RES Renewable energy gadgets for NE Region, pp: 48-51, compadium, Promotion of improved agricultural equipments and technology in NEH region, 22-25 November 2011.

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2. Dr. A. K. Mishra, Deputy Director Research, CAU, Imphal; email: akm.caepht@gmail.com

TECHNOLOGY:
NECTAR-FM-73

1. **Name of the technology:** Low-cost gravity-based ropeway for transportation of agricultural produce and inputs
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of release:** 2012
4. **Description of technology with salient features:**

The gravity-based rope way facilitates to lift agricultural produce from up-hill/down-hill fields and carry the produce to the accessible roads. Hill farmers have to carry their farm produce on head and particularly face tremendous problem if their farm is away from the home and across the river. The gravity-based ropeway is suitable under such conditions. The mechanics of the gravity ropeway is based on the rope and pulley system operating on gradients due to gravitational force without the use of external power source. It consisted of two trolleys (carriage) 620 x 480 x 450 mm size made rolling on two overhead pulleys suspended from two separate steel support fixed at lower and upper points (stations) through support columns. These trolleys are connected to a single looped MS wire rope (control cable or hauling rope) passing around cast-iron flywheel having groove to accommodate control cable at each end. The installation site must be clear from any obstruction and having slope between 15^0 – 30^0. The specification of installed ropeway is given below and it is shown in **Fig. 1** & **2**. The size of installed ropeway is as follows:

Support span, m	= 150
Hauling span, m	= 130
Elevation difference, m	= 75
Slope, degree	= 30

Brief Specification

Sl. No.	Component	Specification	Quantity (No.)
(1) Upper station			
(i)	Support column	MS pipe, 100 mm dia and 300 mm height	01
(ii)	Flywheel	Cast iron, heavy duty, 600 mm dia, fitted on iron rail support with two roller bearings	01
(iii)	Brake system	Wooden shoe type, hand lever control	01
(2) Lower station			
(i)	Support column	MS pipe, 100 mm dia and 300 mm height	01
(ii)	Flywheel	Cast iron, heavy duty, 600 mm dia, fitted on iron rail support with two roller bearings	01
(3) Control cable		150 m loop between lower and upper station fly-wheel, 6 mm dia rope, 0.20 k gm^{-1} weight	01

Sl. No. Component	Specification	Quantity (No.)
(4)Support cable	150 m length between lower and upper station, 10 mm dia rope, 0.60 kg m^{-1} weight	01
(5) Tie rope	6 mm dia, 20 m length, 0.20 kg m^{-1} weight	02
(6) Carriage (trolley)	620 x 480 x 450 mm size made of MS flat weighing 30 kg	02
(7) Span	130 m	-

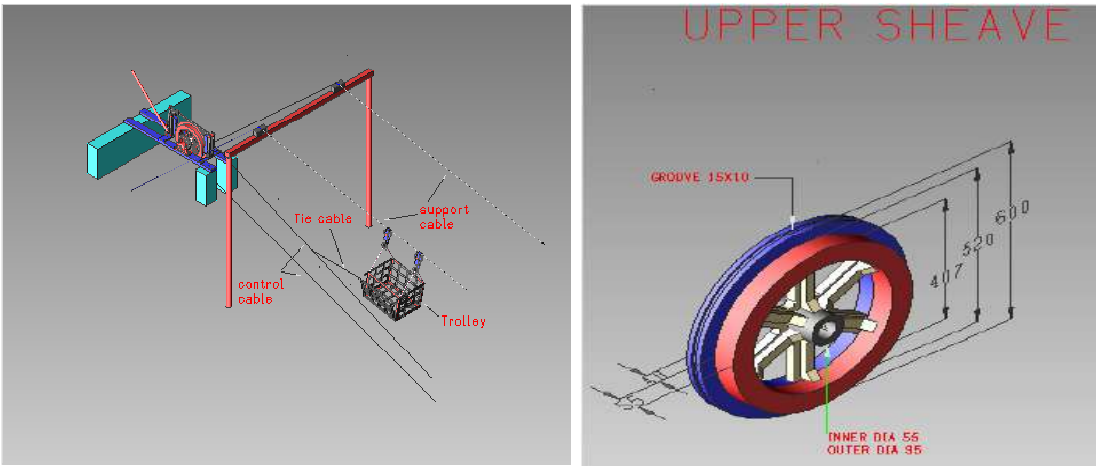

Fig. 1 Showing upper station of gravity rope way and sheave

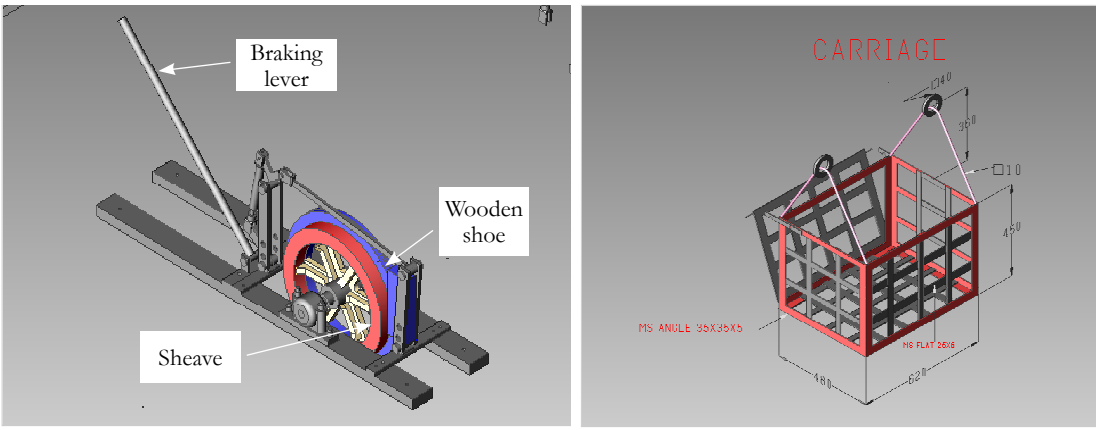

Fig. 2 Braking system and carriage (basket)

Fig. 3 Ropeway being used to carry wood from roadside to near river

Operation of gravity ropeway is very simple. The material to be carry is kept on one basket and some load on the other basket at another station. The brake with wooden brake shoe as fixed at the upper station regulated the speed of the moving carriages. When the brake is released, the basket at upper station start moving downside due to gravity and basket at lower station starts coming up due to counter weight of upper basket. After, field testing (**Fig. 3**) it was concluded that weight ration required to lift or raise the material is higher for lower weight to be carried and lower for higher weight to be carried. It was 4:1) downward to upward to carry 20 kg load and decreased to 1.5:1 for 60 kg load to carry.

5. **Critical inputs required:**

   Dead weight like stone or sand bag to act as counter weight

6. **Observations to be recorded:**

   Downward load

   - Lifting load
   - Speed

7. **Target users/stakeholders:** MTTC/ KVKs/Line department/Companies

8. **Precaution(s) with the technology:** The speed of ropeway depends on the slope and weight being carried and speed is controlled by applying the brake at sheave. Therefore, weight ration must be calibrated by the experts before use by the farmers. Farmers must be given intensive training to operate the ropeway.

9. **Advantage/Benefits/Utility of the technology:** Gravity ropeway does not require any additional source of power hence fossil fuel is saved.

10. **Economics of the technology/ Benefit: Cost Ratio:**

    Material handling cost is about Rs. 0.50 kg^{-1} as compared to about Rs. 2.00 kg^{-1} for manual carrying for the same distance and slope. The BCR is about 1: 2.4.

11. **Technology developed under the project:** Sub-project under AICRP on Ergonomics and Safety in Agriculture funded by ICAR, New Delhi.

12. **Investigators/ inventors:**

    T. K. Khura, S. N. Yadav, S. K. Rautaray and M. S. Seveda: Email: snyadavbpl@yahoo.com; Mobile: 9933469544.

13. **Technology publication:**

    S. N. Yadav and T. K.Khura (2015). Techno-Economic Feasibility Study of Low-Cost Gravity Ropeway for Carrying Agricultural Produce in Hilly Terrain. *Agricultural Engineering Today*, **39**(4): 1-8.

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TECHNOLOGY:
NECTAR-FM-74

1. **Name of the technology:** Portable side feed smokeless cook stove
2. **Source of the technology:** CAEPHT (CAU, Imphal), Ranipool, Gangtok, Sikkim
3. **Year of release/ adoption:** 2012
4. **Description of technology with salient features:**

This is a portable and light weight insulated metallic biomass cook stove, which uses long size fuel wood sticks for continuous operation. The equipment (**Fig. 1 & 2**) is very well suitable for indoor and outdoor cooking of food without production of smoke during combustion. The air supply of this stove is based on the concept of natural draft.

The concept is based on convection, which is the rising of gases hotter than their surroundings. The air is heated in the combustion zone and its density sinks below that of nearby gases. This causes the air to rise, leading to a negative pressure that draws new air into the combustion zone. The process continues as this new air is heated. The user feeds wood through the fuel-opening in the side of the stove, leading to the combustion chamber, where the fuel is burned. Fuel burn-rates, or the amount of fuel used, or burned per unit of time are determined by the user. Rocket-stoves have no active way of controlling fueling characteristics (type, size, species, moisture-content, quantity, etc.) beyond modifying the size of the combustion-chamber or fuel inlet to physically limit the total amount of fuel that can be inserted into the stove and burned at the one time.

Cooking is done on the top of the stove where a cooking vessel, such as a pot or pan, is placed on pot supports directly above the outlet of the riser where the hot combustion products exit the stove. It could be used with vessels of diameter in the range of 19-30 cm. The model, with a corrugated grate design with scraper (for periodical ash removal), can be manufactured by small workshops having facilities for welding, cutting, grinding and punching sheet metal up to a thickness of 3 mm.

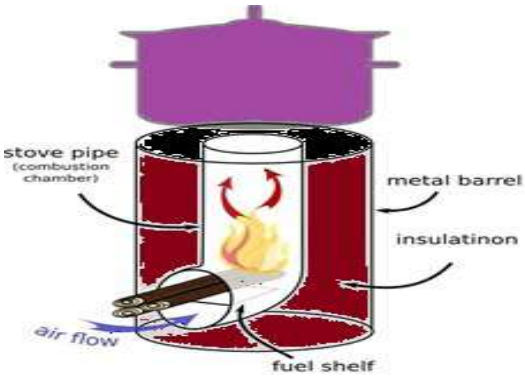

Fig. 1 & 2 Portable side feed smokeless cook stove

5. **Critical inputs required:**

GI sheet, MS Sheet, MS streip, biomass, muffle furnace, hot air oven, bomb calorimeter, thermometer, weighing balance, utensils

6. **Observations to be recorded:**

• Moisture content of biomass, %	• Flame Temperature, °C
• Weight of biomass, kg	• Time taken for cooking measured quantity, h
• Initial water temperature, °C	• Quantity of biomass consumed in cooking, kg
• Final water temperature,°C	• Calorific value of biomass, kcal kg^{-1}

7. **Target users/ stakeholders:** Rural Household/ MTTC/ KVKs/ Line department/ Companies and Equipment manufacturers.

8. **Precaution(s) with the technology:**

The air-dried biomass should be cut into size, i.e. 5-7 cm in diameter and 30-35 cm long should be used as feed stock in the cook stove.

9. **Advantage/Benefits/Utility of the technology:**

Portable side feed smokeless cook stove has great relevance in saving fuel and protecting environment from massive deforestation. Besides, the high fuel efficiency, this has an additional feature of removing smoke, which is harmful to inhabitants in the house. The average thermal efficiency of the cook stove is found to be 31.34%. It saves 39% cooking time over a traditional biomass cook stove. A stable CO_2 concentration is observed in the Smokeless Stove, confirming no significant variation from baseline measurement of 645 ppm at the 95% confidence level. The cook stove is a relatively clean burning device, fuel efficient and easy to operate.

10. **Economics of the technology/ Benefit: Cost Ratio:**

Average fuel saving was found to 3.97 kg h^{-1} by using improved cook stove over the traditional cooking system. Benefit-cost ratio is 1: 3.6.

11. **Technology developed under the project:**

Promotion of Energy Efficient Improved Biomass Cook Stoves in Rural Areas of Sikkim funded by Petroleum Conservation Research Association, Ministry of Petroleum and Natural Gas, Govt. of India, New Delhi.

12. **Investigator(s)/ inventor(s):**

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13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 02: Technology No. 40: Portable side feed smokeless cook stove, p. 74-75.

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TECHNOLOGY:
NECTAR-FM-75

1. **Name of the technology:** Portable PV (photo voltaic) powered forced convection solar dryer

2. **Source of the technology:** CAEPHT, (CAU, Imphal), Ranipool, Gangtok, Sikkim

3. **Year of release/ adoption:** 2012

4. **Description of technology with salient features:**

The portable PV powered forced convection solar dryer is general purpose farm level solar dryer which increased the drying efficiency because of forced circulation of air inside the drying chamber. This can be used to dry almost all types of farm produce, hence is an ideal tool for value addition of farm produce which can generate higher income to the farmer. The portable PV powered forced convection solar dryer (**Fig.1 & 2**) has four main components viz. flat plate collector, drying trays, exhaust fan and solar PV module. The drying chamber is made up of M.S. angle, G.I. sheet and glazing material with the frame size of (700×700) mm^2, opposite wall size of (700×700) mm^2 and front side size of (890×700) mm^2 with the inclination of 45°. The two drying trays are contained inside the drying chamber which is made up of aluminum angle, aluminum strip and steel wire mess. The lower and upper trays are fitted at the height of 150 mm and 350 mm respectively from the base of the dryer. The sizes of lower and upper trays are respectively (680×490) mm^2 and (680×270) mm^2. Air inlet is provided in the one fourth area of the base with the diameter of 600 mm. The drying chamber is insulated with thermocole of 10 mm thickness. At the one side of the dryer an insulated door is provided to facilitate the loading and unloading of the trays. A solar PV module of area (280×230) mm^2 is connected with drying chamber. The solar PV module is tilted to an angle of 45° with respect to horizontal. It is connected to the exhaust fan provided at the opposite wall of the dryer with the help of electric wire.

Specification

Type and model	Forced Convection
Area of the flat plate, m^2	0.49
Loading Capacity, kg/batch	5
Glazing materials	Glass
Air circulation mode	PV powered forced convection
Power of PV Module, Wp	5

5. **Critical inputs required:**

GI sheet, glass wool, Solar PV module, MS angle, Glass sheet, Aluminum angle, aluminum mesh, exhaust fan, wire, hot air oven, weighing balance, thermometer, lux meter

6 **Observations to be recorded:**

- Initial moisture content, %
- Final moisture content, %
- Weight of product, kg
- Ambient air temperature, °C
- Dryer air temperature, °C
- Solar insolation, W m^{-2}

7. **Target users/ stakeholders:** Households/ Farmers/ MTTC/ KVKs/ Line department/ Companies & Equipment manufacturers

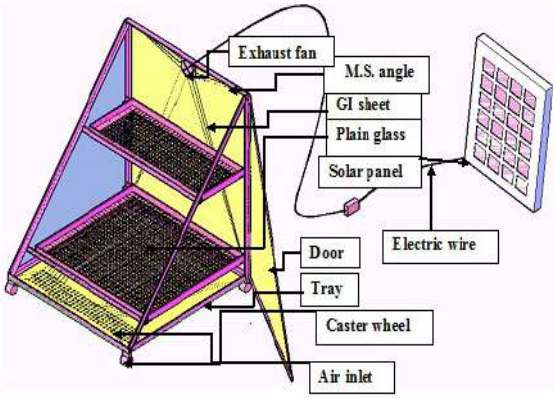

Fig. 1 Schematic diagram of Portable PV powered forced.

Fig. 2 View of Portable PV powered forced convection solar dryer convection solar dryer

7 Precaution(s) with the technology:

The solar collector and PV module should face south. The solar collector and PV module should be away from shadows of tress or buildings outdoor. The solar collector and the recirculating duct should not be touched because of their temperatures. Gloves should be worn while taking out the trays from the drying chamber.

8 Advantage/Benefits/Utility of the technology:

Average air temperature attained in the solar dryer is about 40°C higher than the ambient temperature. The chilli is dried within 32 hours of solar radiation from initial moisture content 80.2% to final moisture content about 10% (w.b.) The efficiency of dryer is 30%. The dryer has high efficiency, uniform drying of product, suitability for NEH region, drying temperature is desirable range, light weight and easy to handle. Drying of chilli in a photovoltaic powered forced convection solar dryer reduces the moisture content from around 80.20% (wet basis) to the final moisture content about 10% in 32 h.

9 Economics of the technology/ Benefit: Cost Ratio:

The cost benefit ratio is 3.83 with a payback period of 1 year 1 month. It can be inferred that the developed solar tunnel dryer is technically as well as economically feasible.

10 Technology developed under the project:

Development and Performance Evaluation of PV Powered Forced Convection Solar Dryer for Small Farmers and Households in NEH Region funded by Central Agricultural University, Imphal, Manipur.

11 Investigator(s)/ inventor(s):

M. S. Seveda: Email: sevda_mahendra@rediffmail.com; Mobile: 8972002379, 7908618953

12 Technology publication(s):

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 02: Technology No. 44: Portable PV powered forced convection solar dryer, p. 76.

Seveda, M. S. (2013). Design of a Photovoltaic Powered Forced Convection Solar Dryer in NEH Region of India. *International Journal of Renewable Energy Research*, **3**(4): 906-912.

Seveda, M. S. (2013). Development and Performance Testing of a Photovoltaic Powered Forced Convection Solar Dryer in NEH Region of India. *International Journal of Scientific and Engineering Research*, **4**(2): 90-96.

Seveda, M. S. (2017). Renewable Energy Technologies for Sustainable Agriculture. Engineering Interventions for Sustainable Agriculture. Editors: Seveda MS, Patle GT and Sherpa, AB (eds.) pp. 19-29, Biotech Books, New Delhi, ISBN 978-81-7622-407-9.

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TECHNOLOGY:
NECTAR-FM-76

1. **Name of the technology:** Energy efficient double pot improved biomass cook stove
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of release/ adoption:** 2013
4. **Description of technology with salient features:**

- The energy efficient double pot improved biomass cook stove (**Fig. 1 & 2**) having two pot holding places is designed to meet the cooking requirement of the hilly region.
- This stove is sufficient to cook the meal of one family of 10–12 persons and is of permanent nature.
- The special feature of the improved biomass cook stove is bigger size of fire box, which is suitable for big size firewood and light agro waste type of fuel.
- The cook stove is suitable for firewood, agro waste and dung cakes. Bigger sized wood may also be used at the fuel burning rate of 1.00 kg h^{-1}.
- The average thermal efficiency of these double pot energy efficient improved biomass cook stoves were observed as 28.65%, which is within the range of values of thermal efficiency of several similar works all over the world.
- The thermal efficiency of the double pot energy efficient improved cook stove was about 200% more than that of the traditional biomass cook stove.
- The thermal efficiency of traditional biomass cook stove and energy efficient double pot improved biomass cook stove are respectively 10–11% and 26-28%.

Type and model	Energy efficient double pot improved biomass cook stove
Body (L×B×H), mm	790 × 360 × 250
First pot diameter, mm	200
Second pot diameter, mm	180
Fire box opening (D × L), mm	200 × 160
Chimney (D × L), mm	76 × 3000
Average thermal Efficiency, %	27
Unit price, Rs.	1,000

Fig. 1 Energy efficient double pot improved biomass cook stove

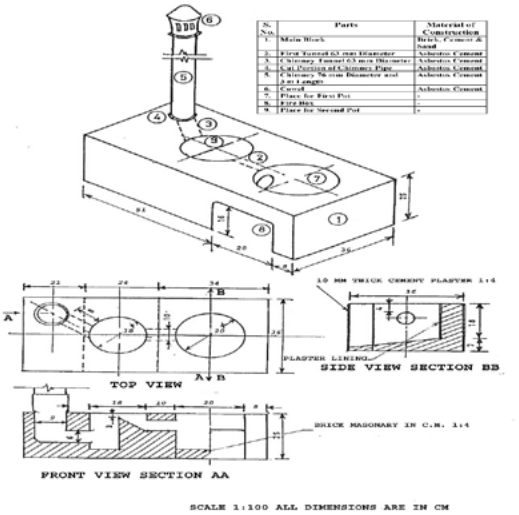

Fig. 2 Drawing of energy efficient double pot improved biomass cook stove

5. Critical inputs required:

Bricks, cement, sand, chimney pipe, biomass, muffle furnace, hot air oven, bomb calorimeter, thermometer, weighing balance, utensils

6. Observations to be recorded:

• Moisture content of biomass, %	:	• Flame Temperature, °C	:
• Weight of biomass, kg	:	• Time taken for cooking measured quantity, h	:
• Initial water temperature, °C	:	• Quantity of biomass consumed in cooking, kg	:
• Final water temperature, °C	:	• Calorific value of biomass, kcal kg^{-1}	:

Target users/ stakeholders: Rural Households/MTTCs/KVKs/Line department/Companies

8. Precaution(s) with the technology:

To avoid cracking of the plaster, fuel burning may be gradually increased to full scale over a period of 3 days. Both the pots of improved biomass cook stove should be used simultaneously. Outer surface of the improved biomass cook stove gets heated up due to continuous use. A mud plaster may be applied on the outer surface to avoid skin burns. The chimney pipe creates the draft and also takes away smoke and fuel gases high into atmosphere. Carbon deposited on the inner surface of chimney. The chimney pipe and the connecting tunnels should be cleaned periodically to ensure efficient operation of the improved biomass cook stove. It should be clean every one-month interval by a bamboo.

9. Advantage/Benefits/Utility of the technology:

The average thermal efficiency of energy efficient double pot improved biomass cook stoves was observed as 28.65%, which is within the range of values of thermal efficiency of several similar works all over the world. The thermal efficiency of the energy efficient double pot improved cook stove was about 200% more than that of the traditional biomass cook stove. Thus, the use of the energy efficient double pot improved biomass cook stove conserves the biomass and fuel wood. It also reduces harmful emission with particulate dispersion for ensuring smoke free healthy environment within the household. The CO concentration measured in the kitchen with a double

pot energy efficient improved biomass cook stove was 50% less than that of the emitted by traditional biomass cook stove. Similarly, there was CO_2 reduction of about 3.2 times when the traditional cook stoves were replaced by double pot energy efficient improved biomass cook stoves. Smokeless environment of kitchen is achieved by energy efficient double pot improved biomass cook stove. Pollution emission in the kitchen is lower than traditional biomass cook stove.

10. Economics of the technology/ Benefit: Cost Ratio:

Energy efficient double pot improved biomass cook stove saves 70% fuel (2.67 kg wood saved by one improved biomass cook stove) and 64.28% saving in cooking time. Therefore, about 975 kg y^{-1} $stove^{-1}$ can be saved by use of these energy efficient cook stoves. B/C ratio is 5.1:1.

11. Technology developed under the project: Promotion of Energy Efficient Improved Biomass Cook Stoves in Rural Areas of Sikkim funded by Petroleum Conservation Research Association, Ministry of Petroleum and Natural Gas, Govt. of India, New Delhi.

12. Investigator(s)/inventor(s):

M. S. Seveda; Email: sevda_mahendra@rediffmail.com; Mobile: 8972002379, 7908618953

13. Technology publication(s):

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 02: Technology No. 43: Modified double pot improved biomass cook stove, p. 77.

Seveda M. S. (2014). Development of modified double pot improved biomass cook stove for adoption in NEH region of India.*CAU Farm Magazine*, **4**(2): 18-19.

Seveda, M. S. (2017). Renewable Energy Technologies for Sustainable Agriculture. *In*: Engineering Interventions for Sustainable Agriculture. M. S. Seveda, G. T. Patle and A. B. Sherpa (eds.) pp. 19-29, Biotech Books, New Delhi, ISBN 978-81-7622-407-9.

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TECHNOLOGY:
NECTAR-FM-77

1. **Name of the Technology:** Biomass based hot air dryer
2. **Source of the Technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of release/development/ adoption: 2013**
4. **Description of technology with salient features:**

The biomass based portable hot air drier (**Fig. 1 & 2**) is designed for drying 20 kg batch^{-1} of freshly harvested large cardamom and other vegetables crops. The large cardamom dried at controlled drying temperatures of 55^{0}C and produces dried cardamom with pink colour and an average 11-12% moisture content suitable for safe storage and marketing. The stoves/ gasifier used for drying with smokeless heat has high thermal efficiency and uses fuel wood cut to small pieces, wood charcoal and briquettes made by charring of loose biomass for conservation of energy and generation of hot air needed for drying of wet large cardamom in short time for grater quality product.

Fig. 1 Biomass based hot air portable dryer for large cardamom and other drying

Fig. 2 & 3 Drying of fresh large cardamom (retaining pink colour) and turmeric, /ginger in dryer

Fig. 4 Drying of potato slice in hot air dryer and fried potato chips

During full load testing 10-12 hours were required for drying 20 kg fresh cardamom in single layer drying and the moisture content could be reduced from 75.4 to 11.5% (wb). The cured large cardamom dried by rice husk gasifier stove retains original pink colour as shown in **Fig. 2**, whereas with fuel wood gasifier stove cured cardamom are usually found to have dark brown colour (**Fig. 3**). These dryers help to save 60-70% fuel and can be used for drying other high value crops, spices and vegetables and help to enhance income of small farmers in rural areas. The drying of potato slice (**Fig. 4**) was achieved in 6-8 hours, providing a quality product for marketing at village level as value added product. The fresh turmeric rhizomes and ginger have been dried in 20-25 hours for making turmeric & ginger powder at village level and saves time and energy. The cost of drying for varied types of materials ranged between Rs 1.50-3.50 kg^{-1} using this dryer. The multipurpose dryer is suitable for varied types of drying needs at low unit price of Rs. 20,000 including improved stove.

5. **Critical inputs required:** Biomass stove, briquettes/coke stove, temperature control, ventilation for moisture,

6. **Observation to be recorded:** Heating temperature, drying temperature, moisture content (wet/dry basis) for fresh and dried products

7. **Target users/stockholders:** Farmers, small scale entrepreneurs, SHGs, KVKs and others

8. **Precaution(s) with the technology:** Heat controlled**,** proper circulation of hot air and moisture outs from dryer during operations, avoid smoke in direct contact with materials from stove, use of only smokeless heat from stove/ Avoid contact of skin with dryer

9. **Advantage/ Benefits/ Utility of technology or product:** Portable, fuel saving, time saving, low cost, good colour dried products in less time, value addition and useful in income generation.

10. **Economics of technology/ cost: benefit ratio:** 1 : 2

11. **Technology developed under the project:** ICAR-AICRP ON RES

12. **Investigator(s)/ inventor(s):** A. K. Mishra and P. K. Srivastava: Mobile No.: 9826328767/ 8319609685; email: akm.caepht@gmail.com

13. **Technology publication(s):**

Mishra, A. K. and Srivastava, P. K. (2016). Design and development of biomass base hot air dryer for large cardamom. *CAU Research Newsletter,* **7**(2): 3-4.

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2. Dr. A. K. Mishra, Deputy Director Research, CAU, Imphal; email: akm.caepht@gmail.com

TECHNOLOGY:
NECTAR-FM-78

1. **Name of the technology:** Two rows manual rice transplanter
2. **Source of the technology:** CAE&PHT (CAU, Imphal) Ranipool, Gangtok, Sikkim
3. **Year of release/ adoption:** 2013
4. **Description of technology with salient features:**

At present six row rice manual transplanters are available commercially which were not found suitable for narrow terraces of Sikkim. The same has been modified by reducing the number of rows into two so that it can work on narrow terraces of Sikkim. The machine mainly consists of a tray with two partition (one each for each row), two fingers to pick up the two to three seedlings at a time, a wooden float, handle to actuate the finger and operate the machine, a double ended screw mechanism (**Fig. 1**). To operate the machine, the mat type nursery is kept in the tray as shown in **Fig. 2**. An operator pulls the machine in backward and push the handle to pick up the seedling by the finger from the tray. By pushing the handle again, the seedlings are transplanted into the puddled soil. The operator pulls back the machine and repeat the operation. One person can transplant in two rows at a time avoiding bending posture of traditional transplanting. The row spacing is fixed to 200 mm. The plant to plant spacing depends on the skill of operator as it depends how much the machine is pulled back. One person can transplant about 100 m^2 in one hour (about 0.04 ha d^{-1} of 4 h as the operator cannot operate it for more than 4 h in day continuously in puddled soil). The machine was tested and demonstrated in the farmer's field (**Fig. 3**).

Fig. 1 Two-row rice transplanter

Fig. 2 Placement of mat type nursery in tray for transplanting

Fig. 3 Training to line department officials about the preparation and functionality of machine

Specification:

Working width: 400 mm

Weight: 30 kg including the weight of seedlings.

5. **Critical inputs required:**

- Mat type nursery
- One operator and one helper

6. **Observations to be recorded:**

- Work rate, Field efficiency, Floating hills, Missing hills

7. **Target users/stakeholders:** MTTC/ KVKs/farmer/companies

8. **Precaution(s) with the technology:**

- Size of the mat of the nursery should match to the size of tray
- The height of nursery should not be more than about 15 cm to avoid seedling floating
- Land preparation and puddling should be thoroughly done and soil surface should be smooth and free from any trace
- Height of standing water should be about 2 cm at the time of transplanting
- The operator must be trained to maintain plant to plant spacing

9. **Advantage/Benefits/Utility of the technology:** (i) Transplanting can be done in line hence increase in productivity (ii) Bending posture can be avoided therefore it is comfortable for the operator.

10. **Economics of the technology/ Benefit: Cost Ratio:** Cost of the machine is about Rs 4,000 (in year 2013) and cost of transplanting one ha rice is by this machine is about Rs 7,500.00.

11. **Technology developed under the project:** Departmental activities

12. **Investigator(s)/inventor(s):**

    S. N. Yadav**:** Email: snyadavbpl@yahoo.com; Mobile: 9933469544.

13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 02: Technology No. 52: Two raw manual rice transplanter p. 89-90.

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TECHNOLOGY:
NECTAR-FM-79

1. **Name of the technology:** Improved animal drawn wedge plough
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2013
4. **Description of technology with salient features:**

- This equipment is an improved version of traditional plough made of mild steel which provides more working width as compared to traditional plough (local wooden plough). Animal drawn improved wedge plough is used for primary tillage operation (deep tillage). and is suitable for terrace land of hilly track due to light weight. It is useful for ploughing irrigated land during field preparation for paddy crop as well as for seed bed preparation in dry lands since it does not leave back furrow and dead furrow in the field.
- The animal drawn improved wedge plough (**Fig. 1 & 2**) consisting of handle, shoe, share and beam (overall dimension: handle height 800 mm, shoe length with share 600 mm, width 210 mm, weight: 12 kg, unit Price Rs 1200).
- The field capacity of wedge plough is 0.025 ha h^{-1}(250 sq. m) and average draft of plough is 45 kg. The cost of operation of improved wedge plough has been estimated as Rs. 2100 ha^{-1}.
- This improved plough provides more working width (210 mm) as compared to traditional plough (local wooden plough) having (100 mm width, work rate 0.012 ha h^{-1} at average draft of 48 kg with a depth of operation of 100 mm).
- The improved wedge plough was operated in 250 m^2 area. The net saving in cost of operation by improved CAEPHT design plough is estimated as Rs. 400 ha^{-1} over traditional plough (Rs. 2500 ha^{-1}).

Improved animal drawn wedge plough reduces the drudgery and covers more area in a season for cultivation.

Function: It is used for primary tillage for seed bed preparation in wet and friable moisture conditions.

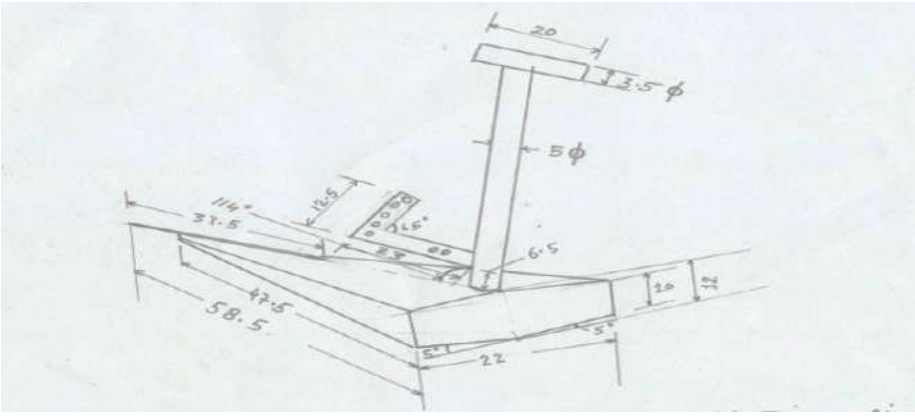

Fig. 1 Sketch of the improved wedge plough (all dimensions in cm)

Field performance: On farm trial of improved animal drawn plough was conducted on terraces of farmer's field (Mr. Roop Narayan Bhattarai, Village Samlik Marchak East Sikkim) as shown in **Fig. 3**. The **Table 1** presents the test results of this implement.

Table 1 Field test trials of improved animal drawn wedge plough

Sl. No.	Parameters	Value
1	Tested area, m^2	700
2	Moisture content, %	24
3	Working width, mm	210
4	Depth of operation, mm	110
5	Average speed of operations km h^{-1}	1.2
6	Average draft, N	450
7	Theoretical field capacity ha h^{-1}	0.032
8	Actual field capacity ha h^{-1}	0.025
9	Field, efficiency, %	78
10	Cost of operation Rs ha^{-1}	2100
11	Net saving over traditional plough Rs ha^{-1}	400

Fig. 2 Developed improved wedge plough

Fig. 3 Testtrial of improved wedge plough at farmer's field

5. Critical inputs required:

- Improved wedge plough
- Animal: A Pair of draught animals
- Labour/Operator: One

6. Observations to be recorded:

- Soil moisture content (d b) %
- Avg. width of terrace, m
- Working width, mm
- Speed of operation, km h^{-1}
- Length of terrace, m
- Area of terraces, m^2
- Depth of operation, mm
- Draft of the implement, kg

- Field capacity, ha h^{-1}
- Cost of operation, Rs ha^{-1}
- Field efficiency, %

Target users/stakeholders: MTTCs/ KVKs/Farmers/companies/ innovators

8. **Precaution(s) with the technology:** To avoid rust on wedge plough keep it in a dry and closed space after use. The adjustment for operating depth should be taken care otherwise draft will be more and animals feel discomfort.

9. **Advantage/Benefits/Utility of the technology:** The developed improved wedge plough is simple in design and no special skill in fitting and adjustment was required. This improved plough covers more working width and requires less draft as compared to traditional plough (local wooden plough) and is advantageous with cost economics.

   The net saving in cost of operation by improved CAEPHT design wedge plough is estimated as Rs. 400ha^{-1} over traditional plough (Rs. 2500ha^{-1}).

10. **Economics of the technology/ Benefit: Cost Ratio:**1: 1.19

11. **Technology developed under the project:** AICRP on UAE Centre of CAEPHT (CAU), Gangtok (Sikkim)

12. **Investigators/ inventors:** S. K. Chauhan**:** Email: chauhansujeetkumar@gmail.com; Mobile: 8436711386.

13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalaya. pp. 312: Chapter 02: Technology No. 45: Animal drawn improved wedge plough: 80-81.

Chauhan, S. K., Yadava, S. N. and Srivastava, P. K. (2016). Efficient utilization of draught animal in crop-livestock integrated farming system for small and marginal farmers of NEH. *CAU Souvenir-Regional Agri. Fair*, February 3-5, 2016: 73-78

Tiwari, R. K. and Chauhan, S. K. (2013). Feasibility assessment of animal drawn improved equipment on terraces for rice and maize crops in Sikkim. *CAU Farm Magazine*, **3**(3):38-39.(ISSN: 2279-0454).

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TECHNOLOGY:
NECTAR-FM-80

1. **Name of the technology:** Animal drawn multipurpose tool frame with attachment
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2013
4. **Description of technology with salient features:**

It is a multi-purpose equipment (**Fig. 1**) consisting of ground wheel, main frame, handle, hitch, beam and two hollow square sections for depth adjustment. The attachments of light weight are fitted to it. The main frame is made of round section of galvanized pipe. The mould board plough (150 mm size), two ridges (170 mm size each), single row potato digger (200 mm size), and sowing attachments for sowing of maize in two rows can be attached on multi-purpose tool frame. The draft of all attachment varies 25-40 kg.

Function: For performing different unit operations *viz*., ploughing, ridge making, sowing, potato digging and intercultural operations by using same unit by fitting appropriate attachments, as described below:

(i) CAEPHT mould board plough (Fig. 2)

Function: it is used for ploughing operation in hilly terrain.

Mould plough (one of the attachments of multipurpose tool frame) weight 10 kg, width 150 mm, and unit price Rs. 1000. The work rate of plough is 0.021 ha h^{-1}. The average draft of plough is 38 kg corresponding depth of operation is 100 mm. The cost of operation of the mould board plough is Rs 1760 ha^{-1}. The net saving in cost of operation by improved c is estimated as

Fig. 1 Multipurpose tool frame

Fig. 2 Improved mould board plough

Fig. 3 Ridger plough

Fig. 4 Animal Drawn Improved Maize Planter

Rs. 1548 ha^{-1} over traditional plough (Rs. 3308 ha^{-1}).

(ii) Ridger plough (Fig. 3)

Function: For planting of potato and ginger in hilly terrain.

Ridger plough (one of the attachments of multipurpose tool frame) weight 12 kg, width 512 mm, and unit price Rs. 1500. The work rate of ridger is 0.05 ha h^{-1}. The average draft of plough is 40 kg corresponding depth of operation is 80 mm. The cost of operation of the ridger plough is 470 Rs. ha^{-1}.

(iii) Animal Drawn Improved Maize Planter (Fig. 4)

Function: It is used for planting of maize seeds.

The overall dimensions of maize planter are 730 x 700 x 960 mm and its weight with seeding attachment is 19.8 kg. The work rate of Maize planter is 700 sq m h^{-1}. The average draft of machine is 25 kg with 45 mm the depth of sowing.

The cost of operation for sowing of maize is Rs. 650 ha^{-1}. The net saving in cost of operation by improved maize planter is estimated as Rs. 850 ha^{-1} over traditional maize sowing (work rate 0.033 ha h^{-1}) by traditional wooden plough behind seed dropping method (Rs. 1500 ha^{-1}).

Field performance:

The College of Agricultural Engineering Post Harvest Technology (CAEPHT), CAU, Centre of the All India Coordinated Research Project on Utilization of Animal Energy conducted FLD of maize planter (one of the attachments of CAEPHT developed multipurpose tool frame) on farmer's (Mr. Balkrishna Bhattarai, Village: Upper Samlik Marchak, Distict: East Sikkim) field on 21.3.2016. The performance data are presented in **Table 1**.

Table 1 Front line demonstration of maize planter(one of the attachments of CAEPHT developed multipurpose tool frame)

Sl. No.	Parameters	Value
1	Tested area, m^2	200
2	Moisture content, %	22
3	Working width, mm	600
4	Depth of sowing, mm	50
5	Average speed of operations km h^{-1}	2.2
6	Average draft, N	255
7	Theoretical field capacity ha h^{-1}	0.132
8	Actual field capacity ha h^{-1}	0.070
9	Field, efficiency, %	53
10	Cost of operation Rs ha^{-1}	650
11	Cost of operation Rs h^{-1}	42
12	Command Area of maize planter ha/annum	2

5. **Critical inputs required :** Multipurpose tool frame with attachments; Animal: A Pair of draught animals; Labour/ Operator: One

6. **Observations to be recorded:**

- Soi l moisture content (db) %
- Avg. width of terrace, m
- Working width, mm
- Speed of operation, km h^{-1}
- Field capacity, ha h^{-1}
- Cost of operation, Rs ha^{-1}
- Length of terrace, m
- Area of terraces, m^2
- Depth of operation, mm
- Draft of the implement, kg
- Field efficiency, %

7. **Target users/stakeholders:** MTTCs/ KVKs/Farmers/companies/ innovators

8. **Precaution(s) with the technology:** Machine should be properly calibrated as required rate before going to sowing in farmers. Maize planter is used in well prepared seed bed before sowing operation.

9. **Advantage/Benefits/Utility of the technology:** In multipurpose tool frame the various attachments (i.e., mould board plough, seeding, and ridge maker) can be attached on single frame which is cost effective to the farmers. The multipurpose tool frame is used for different unit operations in major crops (including maize) except rice.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1 : 2.3

11. **Technology developed under the project:** ICAR-AICRP on UAE Centre of CAEPHT (CAU), Gangtok, Sikkim

12. **Investigator(s)/inventor(s):**S. K. Chauhan**:** Email:chauhansujeetkumar@gmail.com; Mobile: 8436711386.

13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 02: Technology No. 46: Animal drawn multipurpose tool frame with attachment: 81 - 83.

Tiwari, R. K., Chauhan, S. K., Yumnam, Jekender Singh and Chaudhuri, Deepak (2016). Evaluation of Animal Drawn Improved Multi-Purpose Tool Frame with Planting Attachment for Maize- A Case Study in Sikkim. *Agricultural Engineering Today*, **40**(1): 32-39. (ISSN: 0970-2962).

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TECHNOLOGY:
NECTAR-FM-81

1. **Name of the Technology:** Portable biomass based forced hot air dryer
2. **Source of the Technology:** CAEPHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of release/development/ adoption:** 2013
4. **Description of technology with salient features:**

The relative humidity in North East region is comparatively higher and the ambient temperature is lower in comparison to other plain regions of the country. This makes drying of food material difficult and also makes them liable to be infected during storage leading to food losses. Further the cloudy days also make utilization of solar radiation difficult which further escalates the food loss problem. The present technology is an alternative energy efficient drying technology which uses loose bio mass for heating.

The main technology consists of forcing smokeless hot air from stove through a central port by blower for the drying operations. This type of dryer has flexibility to hold drying material from 50 to 150 kg by adjusting the outer net.

This smokeless stove operated hot air drier could be successfully used for curing of 150 kg wet large cardamom, ginger flakes, turmeric rhizomes whole & flakes, early harvested paddy and maize cobs for reducing moisture for safe storage and other vegetables & leaves for bulk drying in 24-48 hours under cold and humid climate of NEH. This dryer has also been tested for drying of leaves showing very good results by retaining the green colour used for making leaves powder of mint, coriander, Maringa, neem and other.

- **Dryer details**

High capacity hot air dryer consists adjustable perforated cylindrical bin, single phase electric blower with an inverted funnel and a cylindrical plenum chamber (inner cylinder) containing a fine wire mesh through which hot air passes through drying materials, a biomass/ gasifier stove for smokeless hot air and 90 degree bent metallic pipe for heat transfer through plenum chamber by suction of hot air from stove.

- **Specification**

Size, (Outer diameter–Flexible x height, mm: 800±100 x 900), Inner plenum chamber size: (diameter x height, mm: 300 x 900)

Loading Capacity, kg: 50 to 150 kg; curing temp.,^{0}C: 50-60, Curing time, h; 8-24

Weight, kg: 35.0; Fuel: wood, briquettes, electric blower 110W,

- **Performance**

Drying of high moisture content materials through developed forced hot air dryer (**Fig. 1 & 2**) removes the moisture contents very fast without loss of colour of drying material. The innovative design of forced air dryer improves the quality of dried turmeric rhizomes, ginger, cardamom capsules, green leaves by retaining the natural colour and volatile oil, and also removes the burnt smell. The gasifier stove burns briquetted fuel hand made by charcoal dust more efficiently for transmission of hot air without smoke resulting in the saving of fuel over the traditional practice of drying large cardamom in Sikkim by traditional kiln (Bhatti).

Fig. 1 & 2 Portable Biomass based forced hot air dryer under operation (Drying Fresh large cardamom)

Fig. 3&4 Dried large cardamom retaining original pink colour dried with hot air dryer and traditionally dried in Bhatti

- **Benefit over traditional practice**

  Fuel saving

5. **Critical inputs required:**

   Smokeless fuel- briquettes, charcoal, fuel wood, Single phase electric power for air blower (220 V), temperature gauge for temperature observation during material drying, stirring of materials upside-down during operation of two hours with hot air drying for uniform drying. Manpower-one

6. **Observations to be recorded:** Wet/ dry moisture content of drying materials (before& after drying), temperature of hot air temperature at inlet & outlet point, ambient temperature and ambient relative humidity inside and outside.

7. **Target users/stockholders:** Farmers/ rural people/unemployed youth/ MTTCs/KVKs

8. **Precaution(s) with the technology:** Avoid direct contact with stove to prevent skin burn, regular monitoring of drying temperature with normal heat, stirring

of drying materials upside-down during operation of two hours with hot air drying for uniform drying, after drying operation done material should be spread in flour for curing and avoid slugging during night

9. **Advantage/Benefits/Utility of technology or product:** These dryers helps to save 60-70% fuel (wood and other), Suitable for drying with hot air without dependency on solar drying, prevent spoilage of materials having high moisture content by fungus, rots, helps to enhance income of small farmers in rural areas for processing with low cost drying

10. **Economics of technology/cost: benefit ratio:** 1:2

11. **Technology developed under the project:** ICAR-AICRP-RES

12. **Investigator(s)/inventor(s):** A. K. Mishra and P. K. Srivastava: Mobile No.: 9826328767/ 8319609685; Email: akm.caepht@gmail.com

13. **Technology publication(s):**

Mishra, A. K. and Srivastava, P. K. (2016). Design and development of biomass base hot air dryer for large cardamom. *CAU Research Newsletter*, **7**(2): 3-4.

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1. Dean, College of Agricultural Engineering and Post Harvest Technology (CAU, Imphal) Ranipool, Gangtok- 737 135, Sikkim. Email: dean.caepht@gmail.com; dean-caepht@gov.in
2. Dr. A. K. Mishra, Deputy Director Research, CAU, Imphal; email: akm.caepht@gmail.com

TECHNOLOGY:
NECTAR-FM-82

1. **Name of the technology:** Manual honey extractor
2. **Source of the technology :** COA (CAU, Imphal), Iroisemba, Manipur
3. **Year of adoption/development:** 2014
4. **Description of technology with salient features:**

Most of the components of this honey extractor are fabricated out of aluminium to avoid rusting and contamination of honey. The main parts of the extractor are a frame with a rotating pulley, a rotor unit for holding bee-hives, an aluminium outer drum opened at both ends and a bottom stainless-steel plate. The four-legged framework and the rotor unit form a single unit and is provided with a rotating pulley with a knob for making the rotor unit rotate in a vertical axis. The rotor unit can accommodate 4 (four) numbers of conventional size beehives at one time. The frame-rotor assembly after fitting 2 or 4 numbers of bee hive frames is placed inside the outer aluminium drum and over a bottom stainless steel plate. When the rotor unit is rotated, honey is thrown outwards which is collected by the aluminium drum. Extracted honey is finally collected in the bottom stainless steel plate. Operation, maintenance and cleaning of the extractor are very simple. About 10 revolutions of the rotating pulley rotate the rotor at a speed of 100-120 rpm which is found optimum for satisfactory honey extraction from one side of the beehive in an average of 10 seconds.

Fig. 1 Manual honey extractor

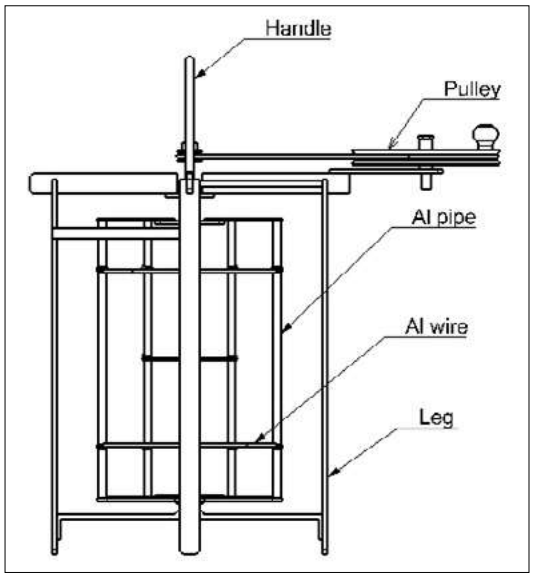

Fig. 2 Detached rotor and frame assembly

Material and specification:

a) Raw material: Aluminum pipe, Aluminum plate, Aluminum sheet, MS flat, MS rod.

b) Machinery:

- Overall dimensions: 50 x 35 x 50cm
- Weight : 4. 1 kg
- Prime mover : Manual

c) Output capacity : 4 honey hives (both sides) in 1 minute

d) Unit cost (per machine): Rs.1,200 (Appr.)

e) Efficiency : 90%

5. Critical inputs/ equipment/ items required:

Honey extractor, manpower (1 no.), bottles etc.

6. Observation to be recorded: Time consumed for extraction of honey from honey hive

7. Target users/ stakeholders: MTTCs/ KVKs/ Farmers/ Honeybee Entrepreneurs

8. Precaution(s) with the technology:

Number of bee hives should be 2 or 4 at a time. One hand of the operator should hold and press down the extractor during operation to control vibration. Belt tension should be adjusted as and when required.

9. Advantage/ Benefits/ Utility of the technology:

The honey extractor requires less capital is and simple in operation. The frame-rotor unit, the outer drum and bottom plate can easily be separated individually by manually pulling out the frame-rotor assembly from the outer drum. Therefore, thorough cleaning before and after each operation can be performed easily and more conveniently. It can eliminate cost of hiring labour for traditional honey extraction by manual swinging. Using this device, a single person can extract honey from many numbers of hives as compared to traditional method which is limited due to high amount of drudgery to the operator. Space requirement for operation is much smaller. Fabrication and repairing of the extractor can be easily carried out in local workshop.

10. Technology developed under the project: Departmental project

11. Investigator(s)/ inventor(s):

P. T. Sharma, Ng. Joykumar Singh and Y. Jekendra Singh: Email:ptsharma4@gmail.com

12. Technology publication:

Sharma, P. T., Ng. Joykumar and Singh, Y. Jekendra (2014). Development of a mechanical honey extractor. *CAU Research Newsletter*, **5**(2): 3-4. ISSN: 2319-3042.

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TECHNOLOGY:
NECTAR-FM-83

1. **Name of the technology:** Animal drawn single row improved potato digger
2. **Source of the technology:** CAE&PHT, CAU (Imphal), Ranipool, Gangtok, Sikkim
3. **Year of adoption/development:** 2014
4. **Description of technology with salient features:**

The developed potato digger (**Fig. 1**) is simple in construction, and has provision for adjustment of depth depending upon nature of crop and size of bullocks. The digger should be well balanced for easy operation. The engaging component (digger blade) is fabricated with mild steel plate hardened at cutting edges. It consists of mild steel plate, shank, L-shape clamps (2 nos.), main frame, clevis, beam and handle. The light weight digger can work up to 150 mm depth. The width of digger is 210 mm and it requires draught of 35 kg.

Specification:

• Overall dimensions, mm	:	730 x 700 x 960
• Weight, kg	:	10.2
• Size of digger blade, mm	:	210
• Unit price, Rs.	:	1,000/-

Performance:

• Effective field capacity, ha h^{-1}	:	0.03
• Cost of harvesting tubers, Rs ha^{-1}	:	3000

Function: Digging of potato tubers grown on raised beds.

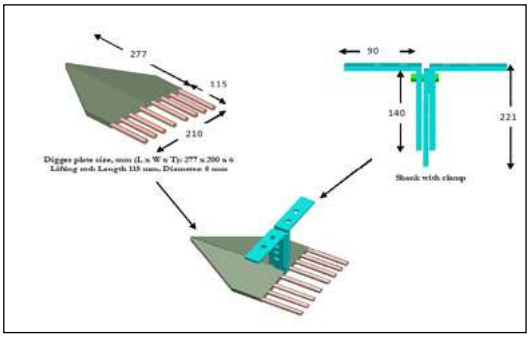

Fig. 1 Single row improved potato digger

Field Trial/ performance:

- A light weight animal drawn improved potato digger was developed and evaluated (Table 1) for digging of potato on terraces and valleys. The test trial of light weight potato digger was conducted (**Fig. 2 & 3**) using local breed of draught animals at Daramdin in Sombaria region of west Sikkim district. The improved potato digger was operated in 1200 m^2 area. The net saving in cost of operation by improved potato digger is estimated as Rs. 1500 ha^{-1} over traditional digging (work rate 0.02 ha h^{-1}) by traditional wooden plough (Rs. 4500 ha^{-1}).

Table 1: Field test trial **of** light weight animal drawn improved potato digger

(village: Darmadin, March, 2014)

Sl. No.	Parameter	Average Values
1	Tested Area, sq.m	1200 sq.m
2	Harvested potatoes size range, mm	40-60
3	Working width, mm	176
4	Bullock speed, kmh^{-1}	1.7

5	Depth of operation, mm	120
6	Average Draft, N	320
7	Theoretical field capacity, ha h^{-1}	0.034
8	Effective field capacity, ha h^{-1}	0.030
9	Field efficiency, %	88
10	Digging efficiency, %	93
11	Labour requirement for digging human, h ha^{-1}	32
12	Labour requirement for picking human, h ha^{-1}	144
13	Cost of operation, Rs h^{-1}	90
14	Cost of operation, Rs ha^{-1}	3000

Fig. 2 & 3 Field trials of the developed light weight potato digger

5. **Critical inputs required:** Potato Digger; Animal: A pair of draught animals; Labour/Operator: one

6. **Observations to be recorded:**

• Area of terraces, m^2	• Digging efficiency, %
• Working width, mm	• Labour requirement for digging human-h ha^{-1}
• Operating Speed (km h^{-1})	• Labour requirement for picking human-h ha^{-1}
• Depth of operation, mm	• Cost of operation, Rs ha^{-1}
• Effective field capacity, ha h^{-1}	• Theoretical field capacity (ha h^{-1})
• Field efficiency (%)	• Draft, N

Target users/stakeholders: MTTCs/ KVKs/ Farmers/companies and equipment manufacturers/ innovators

8. **Precaution(s) with the technology:** The digger should be able to operate at a proper depth of dig the maximum possible potatoes. The transverse dimension of cutting should be kept in such a way that the all the tubes of plant might be dug. The digger should not be clogged due to large quantity of haulm present in field which can be ensured by providing arrangement of the lifter rods properly.

9. **Advantage/ Benefits/ Utility of the technology:** The digger is simple in design and no special skill in fitting and adjustment is required. The digging potatois in terrace using traditional hand tools which make the unit operations arduous and time consuming. However, the developed single row light weight digger covers more

area, is less time consuming with higher work rate and reduces drudgery of labour with reduction in losses of tuber damaged. The net saving in cost of operation by improved potato digger is Rs. 1500 ha^{-1} over traditional digging (work rate 0.02 ha h^{-1}) by traditional wooden plough (Rs. 4500 ha^{-1}).

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 1.5

11. **Technology developed under the project :** ICAR-AICRP on UAE Centre of CAEPHT (CAU), Gangtok, Sikkim.

12. **Investigator(s)/ inventor(s):** S. K. Chauhan**:** Email:chauhansujeetkumar@gmail.com; Mobile: 8436711386.

13. **Technology publication:**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K, Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 02: Technology No. 46(iv): Animal drawn single row improved Potato Digger: 83.

Tiwari, R. K. and Chauhan, S. K. (2014). Development and evaluation of light weight animal drawn improved potato digger for terrace condition. *CAU Farm Magazine*, **4**(3): 33.(ISSN: 2279-0454).

Tiwari, R. K., Chauhan, S. K., Din, M. and Yuumnam, J. (2018). Improved Potato digger in terrace condition of Sikkim India. *International Journal of Agriculture Sciences*, **10**(11): 6211-6214. (ISSN: 0975-3710 & E-ISSN: 0975-9107).

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TECHNOLOGY:
NECTAR-FM-84

1. **Name of the technology:** Animal drawn improved rolling peg type puddler
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2014
4. **Description of technology with salient features:**

- The peg type improved puddler has been designed and developed with the objective to prepare shallow puddledbed on terraces for transplanting of paddy seedlings.
- The puddler isl (**Fig. 1**) Light weight improved rolling peg type equipment (weight: 12 kg, size: 700 mm, unit price: Rs. 3500) consisting of 200 mm size rotor made from 25 x 25 x 5 mm size 04 no. of mild steel angle.
- Each row is welded with 04 pegs (10 x 10 mm size, square bar) of 50 mm length.
- The work rate of puddler is 0.105 ha h^{-1} and average draft is 25 kg.
- It is suitable for states of NEH Region.
- **Function:** It is use for the seed bed preparations of field for transplanting of paddy.
- **Field performance:**

A test trial of developed animal drawn improved rolling peg type puddler was conducted on terraces of farmer's field (Mr. Balkrishna Bhattarai), Village: SamlikMarchak, East Sikkim (**Fig. 2**). It showed higher work rate (0.1050 ha h^{-1}) as compared to the traditional puddling practice by use of dande. The draft was 25 kg. The operation of wedge plough followed by peg type puddler was found to be more energy efficient due to lesser draft required and cost effective compared to the traditional plough followed by dande (wooden leveler and)having lower work rate (0.0650 ha h^{-1}). The **Table 1** shows the test results of the developed peg type puddler.

Table 1 Field test trial **of** animal drawn improved rolling peg type puddler (Village: Samlik Marchak, July 06, 2015)

Sl. No.	Parameter	Average Values	Sl. No.	Parameter	Average Values
1	Length of terrace, m	47	9	Effective field capacity, ha h^{-1}	0.105
2	Width of terrace, m	3.2	10	Field efficiency, %	58
3	Area covered, sq.m	180	11	Puddling index	8.8
4	Depth of standing water, mm	100	12	Performance index	9.2
5	Working width, mm	630	13	Cost of operation, Rs h^{-1}	130
6	Bullock speed, km h^{-1}	2.25	14	Cost of operation, Rs ha^{-1}	1238
7	Depth of puddling, mm	88	15	Benefit: Cost Ratio	1.61
8	Draft, kg	25			

Fig. 1 Developed light weight improved rolling peg type puddler

Fig. 2 Test trial of light weight improved rolling peg type puddler on farmer's field

5. **Critical inputs required:**

- Peg type puddler
- Animal: A pair of bullocks
- Labour/Operator(nos.): One

6. **Observations to be recorded:**

• Area of terraces, m^2	• Average size of terrace(L x W), m
• Depth of standing water, mm	• Working width, mm
• Draft, kg	• Depth of puddling, mm
• Puddling Index	• Effective field capacity, ha h^{-1} (m^2 h^{-1})
• Actual field capacity, ha h^{-1} (m^2 h^{-1})	• Field efficiency (%)

7. **Target users/stakeholders:** Farmers/ Companies & implement manufacturers / innovators

8. **Precaution(s) with the technology:** The peg type improved puddler has been designed and developed with the objective to prepare shallow puddle bed on terraces. Therefore, standing water during the puddling should not be more than 100 mm for better churning of soil.

9. **Advantage/Benefits/Utility of the technology:** The lesser diameter of rotary made of mild steel angle fitted with square pegs and having four rows with four pegs in each row provided more number of revolutions which helped for better puddling of the soil. It has been provided with platform of mild steel rod which floated behind the puddler to facilitate leveling operation in single pass. Due to light weight of the puddler it was easy to turn at headlands and there were no fatigue symptoms of bullocks in terms of changes in respiration rate, pulse rate and body temperature during continuous operations of three hours. There is cost effective and energy efficient operation with higher work rate of 1050 sq. mh^{-1} at cost of operation of Rs 1238 ha^{-1}. Its average draft requirement is 250 N which is 60% lower compared to puddling by traditional plough (560 N).

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 1.61

11. **Technology developed under the project:**

    ICAR-AICRP on UAE centre of CAEPHT (CAU), Gangtok, Sikkim.

12. **Investigator(s)/inventor(s):** S. K. Chauhan**:** Email: chauhansujeetkumar@gmail.com; Mobile: 8436711386.

13. Technology publication(s):

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India. Pub: ICAR-ATARI Zone VII, Umiam, Meghalya, pp. 312: Chapter 02: Technology No. 47: Animal drawn improved rolling peg type puddler: 84 - 85.

Chauhan, S. K., Yadava, S. N. and Srivastava, P. K. (2016). Efficient utilization of draught animal in crop-livestock integrated farming system for small and marginal farmers of NEH. *CAU Souvenir-Regional Agri. Fair*, Pub: DEE, CAU, Imphal. February 3-5, 2016: 73-78.

Tiwari, R. K. and Chauhan, S. K. (2014). Performance Evaluation of Animal drawn Improved Equipment for Puddled Seedbed in Terrace Condition-A Case Study in Sikkim. *Agricultural Engineering Today* (ISSN: 0970-2962), **38(3):** 34-38.

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TECHNOLOGY:
NECTAR-FM-85

1. **Name of the technology:** Animal drawn single row zero till planter
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2015
4. **Description of technology with salient features:**

- The single row multi crop zero- till planter (**Fig. 1**) is fitted with inverted (T) type furrow opener. The weight of the equipment is 11.5 kg and its unit price Rs. 5000. The overall dimensions of the unit are 800 x 570 x 455 mm.
- The zero till planter is provided with sprocket chain drive mechanism and vertical rotor with cups at the periphery for metering of seeds. The average field capacity of the machine is 0.033 ha h^{-1} and average draft is 245 Newton at a seed sowing depth of 45 mm.
- The average cost of sowing by the animal drawn single row zero till planter is Rs. 2500 ha^{-1} while the cost of sowing by the traditional practice is Rs. 5000 ha^{-1}. The zero tillage seeding in single pass at residual moisture content of soil 21% dry basis and 50% saving in cost of operation was found to be advantageous in termsof timeliness compared tothe traditional practice: ploughing by indigenous plough for one pass @ Rs 0.33 m^{-2} and two passes of clod crusher cum leveler (Dande) @ Rs. 0.17 m^{-2}.
- **Suitability for states of NEH Region**: Sikkim, Arunachal Pradesh, Manipur, Tripura.
- **Function:** Suitable for sowing wheat, buck wheat, mustard, black gram etc.

Fig. 1 Single row multi crop zero- till planter

Field performance:

CAEPHT Centre of AICRP on UAE, Ranipool conducted test trial of developed animal drawn single row multi crop zero- till planter for showing of (Yellow Mustard) on terraces of farmer's field (Mr. Roop Narayan Bhattarai), Village: Samlik Marchak, East Sikkim (**Fig. 2**). Table 1presents the results of this performance test.

Table 1 Field performance of the single row crop zero till planter for mustard crop

Sl. No.	Parameters	Average
1	Area (m^2)	110
2	Height of stubbles, mm	102
3	Number of stubbles m^{-2}	15
4	Soil moisture content (db %)	21.0
5	Operating Speed (km h^{-1})	1.33
6	Row to row spacing (mm)	300
7	Seed Rate (kg ha^{-1})	5

8	Depth of sowing (mm)	45
9	Actual field capacity (ha h^{-1})	0.033
10	Theoretical field capacity (ha h^{-1})	0.040
11	Field efficiency (%)	81.63
12	Draft, N	245
13	Cost of operation (Rs m^{-2})	0.25
14	Cost of operation (Rs ha^{-1})	2500

* Considering the prevailing rate of Rs. 500 day^{-1} for pair of bullockswithoperator for a day

Fig. 2 Single row zero tillplanter in operation on farmers (Mr. Roop Narayan Bhattarai, Village; Samlik Marchak East Sikkim) field

5. **Critical inputs required:** Single row zero till planter; Animal: A pair of draught animals; Labour /Operator(nos.): One

6. **Observations to be recorded:**

- Area (m^2)
- Number of stubbles m^{-2}
- Operating speed (km h^{-1})
- Height of stubbles, mm
- Soil moisture content (db %)
- Row to row spacing (mm)
- Seed rate (kg ha^{-1})
- Actual field capacity (ha h^{-1})
- Field efficiency (%)
- Depth of sowing (mm)
- Theoretical field capacity (ha h^{-1})
- Draft, N

Target users/ stakeholders: MTTCs/ Farmers/ KVKs/ Line department/ Companies

8. **Precaution(s) with the technology:** Machine should be properly calibrated to required rate before going to sowing in farmers. field. Never use planker /leveler after sowing of seed by the zero till seed planter.

9. **Advantage/Benefits/Utility of the technology:** Easy transportability of implement from one terrace to other due to light weight. The zero-tillage seeding in single pass by use of single row zero till planter results 50% saving in cost of operation as compared to the traditional practice

10. **Economics of the technology/Benefit: Cost Ratio:** 1: 2

11. **Technology developed under the project:** AICRP on UAE Centre of CAEPHT (CAU), Gangtok (Sikkim)

12. **Investigator(s)/inventor(s) :** S. K. Chauhan**:** Email: chauhansujeetkumar@gmail.com; Mobile: 8436711386

13. **Technology publication(s):**

Gyadi, Karma, Chauhan, S. K. and Kushwaha, R. K. S. (2015). Design refinement and development of light weight animal drawn single row multi crop zero till drill. *CAU Farm Magazine,* **5**(1): 40-42.

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TECHNOLOGY:
NECTAR-FM-86

1. **Name of the technology:** Adjustable saddle for transportation of packload by yak
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2015
4. **Description of technology with salient features:**

- The College of Agricultural Engineering and Post Harvest Technology (CAU, Imphal) Ranipool Centre of All India Coordinated Research Project on Increased Utilization of Animal Energy with Enhanced System Efficiency has developed saddle with harnessing system for pack load transport in hilly areas using yak. The adjustable wooden saddle was developed based on body dimension of 2.5-5.0 years old yaks of Sikkim in the workshop of Farm Power and Machinery Department CAEPHT (CAU, Imphal) Ranipool, Sikkim
- The dimensions of the adjustable wooden saddle are- weight: 2.00 kg, size: L-320 mm, width expandable upto-300 to 400 mm, height expandable upto -150 to190 mm. The unit price is Rs 1000. The **Fig. 1 & 2** shows the CAD of improved adjustable saddle the photograph of which is shown I vide **Fig. 3**.

Function: Useful for Load carrying up to 80-100 kg on steep slopes of 60 degree without excessive fatigue.

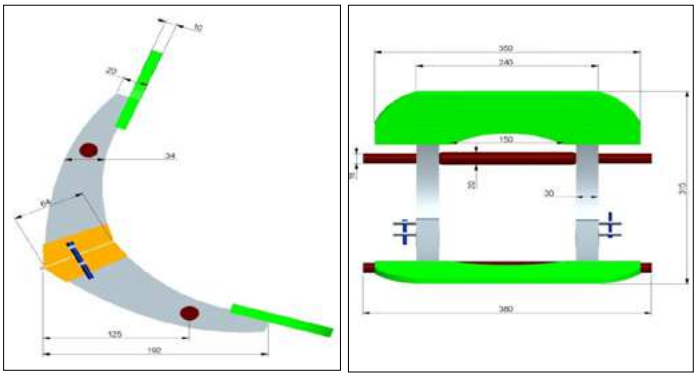

Fig. 1 & 2 CAD of improved adjustable saddle for Yak (dimensions in mm)

Fig. 3 Developed adjustable wooden saddle

Performance

The test trial of the developed adjustable wooden saddle was conducted at Dirang based NRC on Yak farm during February 20-23, 2019 and compared with traditional wooden saddle .The animal using this developed adjustable saddle with padding material (for cushioning effect) and average pack load of 100 kg covered 12 km in 4 h 15 m without excessive fatigue. In comparison to this, the traditional wooden saddle with padding material fitted and pack load of only 80 kg covered 12 km distance in 4 h duration

without excessive fatigue. In both the cases, at half travel distance 45 m rest period was taken by packload animal. In pack load study it was observed that the load carrying capacity of the adjustable wooden saddle was 20 kg more than the traditional wooden saddle. **Table 1** shows the comparative performance of the developed and traditional saddles. While **Fig. 4** shows the demonstration of developed improved adjustable saddle.

Table 1 Comparative performance of the traditional and developed adjustable saddles

Sl. No.	Particulars	Traditional saddle	Improved adjustable saddle
1.	Materials used	Wood	Wood
2.	Weight, kg	2.5	2.0
3.	Price, Rs.	2000	1000
4.	Size, mm	L - 350 W - 340 H-180	L- 320 W- 300 to 400 H- 150 to 190
5.	Animal (Yak), tag no. and date of birth	tag No. 587 16.07.2015	tag No. 587 16.07.2015
6.	Animal (Yak), weight (kg)	350	350
7.	Animal (Yak), Age	3 year 7-month-old	3 year 7-month-old
8.	Body dimension of Yak Girth – meter Length – meter	 2.1 1.5	 2.1 1.5
9.	Atmospheric temperature, ^{0}C	14	14
10.	Total travel distance, km	5.5	5.5
11.	Average travel speed, km	1.5	1.5
12.	Steep slope, degree	60	60
13.	Physiological parameters before trial: Respiration rate/min Pulse rate /min Body temperature,^{0}F	 30 58 103.4	 32 60 103.5
14.	Physiological parameters after trial: Respiration rate/min Pulse rate/min Body temperature, ^{0}F	 112 67 103.7	 120 68 103.9
15.	load, carrying capacity kg	80	100

Fig. 4 Demonstration of developed saddle for load transportation at Dirang Yak farm on February 21, 2019

5. Critical inputs required:

- Adjustable saddle
- Animal: One pack load animal (i.e., Yak or Pony)
- Labour/Operator: One

6. Observations to be recorded:

• Weight of Yak (kg)	• Respiration rate
• Pulse rate (beats min^{-1})	• Speed of yak (km h^{-1})
• Distance travelled (km)	• Time taken (h)
• Load carrying capacity (kg)	

Target users/stakeholders: ITBP/KVKs/MTTCs/Line department/Companies

8. Precaution(s) with the technology: To avoid decay of adjustable saddle keep it in dry and closed space after use. To avoid the injury of animal adjustable saddle should be used with suitable padding material and proper adjustment.

9. Advantage/ Benefits/ Utility of the technology:

a) The adjustable saddle has provision to adjust the width upto 300-400 mm and height upto150-190 mm and can be fitted on one or more animals (Yak).

b) It could sustain 20% more pack load than the tradition saddle.

c) Saved amount Rs. 1000 in each saddle of improved adjustable saddle over the traditional saddle.

10. Economics of the technology/ Benefit: Cost Ratio: 1: 1.25

11. Technology developed under the project: AICRP on UAE Centre of CAEPHT (CAU), Gangtok (Sikkim)

12. Investigator(s)/inventor(s): S. K. Chauhan**:** Email: chauhansujeetkumar@gmail.com; Mobile: 8436711386

13. Technology publication: Nil

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TECHNOLOGY:
NECTAR-FM-87

1. **Name of the technology:** Animal drawn two row zero-till-planter for multi crop use
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2015
4. **Description of technology with salient features:**

The two row multi crop zero- till planter is fitted with inverted (T) type furrow opener. The weight and unit price of two row seed drill are 18.5 kg and Rs. 8000, respectively. The zero till planter is provided with sprocket chain drive mechanism and vertical rotor with 02 No. triangular cells at the periphery for metering of mustard and 10 numbers of triangular cells for metering the seeds.

The average field capacity of the machine (**Fig. 1**) is 0.054 ha h^{-1} and average draft is 320 Newton at a seed sowing depth of 45 mm. The average cost of sowing is Rs. 1500 ha^{-1}. The zero tillage seeding in single pass at residual moisture content of soil 21% dry basis with 70% saving in cost of operation was found to be advantageous in terms of timeliness as compared to the traditional practice: of ploughing by indigenous plough for one pass @ Rs 0.33 m^{-2} and two passes of clod crusher cum leveler (Dande) @ Rs 0.17 m^{-2} .

Function: Suitable for sowing wheat, buck wheat, mustard etc.

Suitability for states of NEH Region: Sikkim, Arunachal Pradesh, Manipur, Tripura

Fig. 1 Two row multi crop zero- till planter

Field performance:

CAEPHT Centre of AICRP on UAE, Ranipool conducted test trial of developed animal drawn Two row multi crop zero- till planter for sowing of yellow mustard on terraces of farmer's field (Mr. Roop Narayan Bhattarai), Village: Samlik Marchak, East Sikkim (**Fig. 2**). Table 1 presents the performance results.

Table1 Field performance of the two-row crop zero till planter for mustard crop.

Sl. No.	Parameters	Average
1	Area (m^2)	115
2	Height of stubbles, mm	104
3	Number of stubbles m^{-2}	12
4	Soil moisture content (db %)	21.0
5	Operating Speed (km h^{-1})	1.30
6	Row to row spacing (mm)	300
7	Working width mm	600
8	Seed Rate (kg ha^{-1})	5
9	Depth of sowing (mm)	45

10	Actual field capacity (ha h^{-1})	0.054
11	Theoretical field capacity (ha h^{-1})	0.078
12	Field efficiency (%)	70
13	Draft, N	320
14	Cost of operation (Rs m^{-2})	0.15
15	Cost of operation (Rs ha^{-1})	1500

Fig. 2 Two row zero till planter in operation on farmers (Mr. Roop Narayan Bhattarai, Village;Samlik Marchak East Sikkim) field

* Considering the prevailing rate of Rs. 500 d^{-1} for pair of bullocks with operator for a day

5. Critical inputs required:

• Seed	• Multi crop two row zero-till-planter
• Animal: A pair of draught animals	• Labour/Operator(nos.): One

Observations to be recorded:

• Area (m^2)	• Height of stubbles, mm
• Number of stubbles per m^2	• Soil moisture content (db %)
• Operating Speed (km h^{-1})	• Row to row spacing (mm)
• Seed Rate (kg ha^{-1})	• Depth of sowing (mm)
• Actual field capacity (ha h^{-1})	• Theoretical field capacity (ha h^{-1})
• Field efficiency (%)	• Draft, N

Target users/ stakeholders: Farmers/ KVKs/ MTTCs/ Line department/ Companies & Equipment manufacturers

8. **Advantage/ Benefits/ Utility of the technology:** Machine should be properly calibrated at required rate before going to sowing in farmer's field. Never use planker/leveller after sowing of seed by the zero till seed planter.

9. **Advantage of technology/variety:** Easy transportation of implement from one terrace to other due to light weight, 70 % saving in cost of operation as the zero-tillage seeding in single pass by use of two row zero till planter as compared to the traditional practice and higher work output because of this reason

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 3.33

11. **Technology developed under the project:** AICRP on UAE Centre of CAEPHT (CAU), Gangtok (Sikkim)

12. **Investigator(s)/inventor(s):** S. K. Chauhan**:** Email:chauhansujeetkumar@gmail.com; Mobile: 8436711386

13. **Technology publication:** NA

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TECHNOLOGY:
NECTAR-FM-88

1. **Name of the technology:** Power tiller operated multi-crop seed drill cum planter
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Gangtok, Sikkim
3. **Year of adoption/development:** 2015
4. **Description of technology with salient features:**

As a practice broadcasting method is followed for sowing and planting of seeds in the NEH region. In this method, proper plant to plant and row to row spacing is not maintained due to which subsequent weeding and intercultural operations becomes difficult and have to be done manually. The yield of the crop is also lower in this method. In order to promote line sowing and planting a two row light weight seed drill cum planter was developed which can be operated by a small power tiller and can be used for all crops.

The developed two row seed drill cum planter can be attached to the rear of a small power tiller. The machine consists of hoppers, metering mechanism, furrow openers, frame, hitching frame, power transmission system, ground wheel and seed tubes. The machine consists of separate hoppers and metering mechanisms for each row. The seed metering system consists of two types of mechanisms viz fluted roller mechanisms for small seed sowing and vertical plate mechanism for planting of large seeds. The fluted roller mechanism is placed just below the vertical plate mechanism. An adjustable gate provided below the vertical plate mechanism is used to divert the seed to the fluted roller mechanism when used as a seed drill for sowing small seeds like wheat, buckwheat etc. The adjustable gate is kept closed cutting off seed flow to the fluted roller mechanism when used for planting large seeds like maize, groundnut etc. and only the vertical plate metering mechanism is used. The machine is provided with a set of vertical seed plates of different sizes for different crops. The **Figs. 1 to 4** shows different views of the developed machine.

Therefore, the machine can be used both as a seed drill as well as a planter as per the seed to be sown. The metering mechanisms deliver seeds to the furrow opener boot through separate seed tubes. The seed drill is provided with a ground wheel at the rear, which drives the metering system through chain and sprocket transmission system. The machine is provided with two wheels on both left and right side, which is used for depth adjustment and transport. The machine was tested for sowing mustard, buckwheat, maize and pea in Sikkim.

Brief specification of machine:

Name of the implement	Power Tiller operated Seed drill cum Planter
Power source	Power Tiller (4.12 kW)
Size (L×B ×H)	71 cm ×5 9 cm × 61cm
Weight, kg	31.2
No. of furrow opener	2
Row to row spacing	Adjustable up to 460 mm

Metering mechanism	Fluted Roller type for sowing
	Vertical cell plate metering mechanism for planting
Power transmission system	Power from ground wheel transmitted to metering mechanisms by chain and sprocket
Type of seeds that can be used	Mustard, pea, buckwheat, soybean, wheat, millet, sorghum etc.
weight of the machine, kg	26
Approx. cost of machine, Rs.	6,500

5. Critical inputs required:

- Power tiller
- One operator
- Multi-crop seed drill cum planter
- Seed to be sown

Fig. 1 Stationary view of the two-row seed drill cum planter

Fig. 2 View of the seed drill cum planter attached to a small power tiller

Fig. 3 View of the seed drill cum planter in operation

Fig. 4 View of the buckwheat crop sown on terraces with the seed drill cum planter

6. **Observations to be recorded:** Field capacity, field efficiency, missing hills, fuel consumption

7. **Target users/stakeholders:** MTTC/ KVKs/ Line department/Farmers/ Companies

8. **Precaution(s) with the technology:** the power tiller should be of 5.5 hp and more power. The operator needs to be trained before operation.

9. **Advantage/Benefits/Utility of the technology:** This machine can be used for sowing small seeds as well as large seeds. The vertical plate in the metering mechanism can be easily replaced with suitable size plates for various seed sizes. The seed rate in sowing small seeds can also be easily adjusted in the fluted roller mechanism as per desired seed rate. The machine ensures line sowing and maintenance of proper seed to seed spacing. About 30-40% seed can be saved as compared to traditional practice of broadcasting.

10. **Economics of the technology/ Benefit: Cost Ratio:**1: 1.1

11. **Technology developed under the project:** ICAR- AICRP on Farm Implements and Machinery.

12. **Investigator(s)/inventor(s):** S. K. Satpathy: Email: sangramkishorsatpathy@gmail.com; Mobile: 9475710905

13. **Technology publication(s):**

Satpathy, S. K. (2016). Progress Report of AICRP (FIM) CAU-Gangtok center, presented in XXX Annual Workshop of AICRP (FIM), PAU Ludhiana, January 28-30, 2016.

Satpathy, S. K. (2016). Design and development of a power tiller operated multi crop seed drill cum planter.*In*: Proceedings of Conference on Innovation in Agricultural Mechanization-Development of Linkage among R&D Institutes-Industry-Farmers, Organized by Department of Agricultural Cooperation and Farmers Welfare, July 7-8, 2016, New Delhi.

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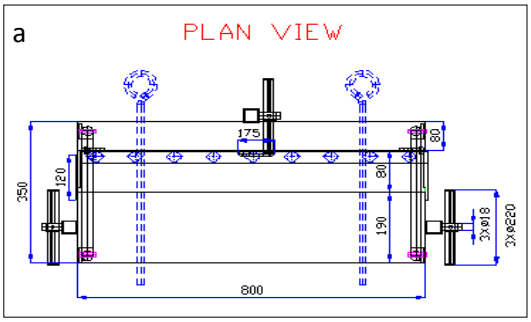
TECHNOLOGY:
NECTAR-FM-89

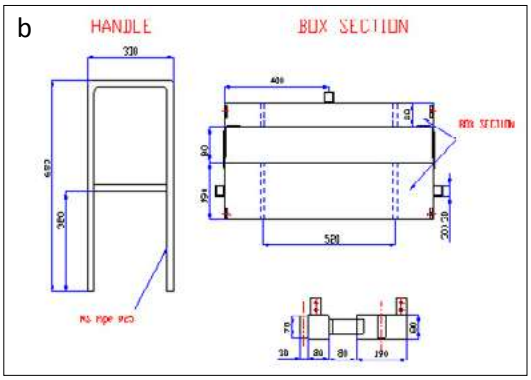
1. **Name of the technology:** Animal drawn clod crusher, leveller cum planker
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Gangtok, Sikkim
3. **Year of adoption/development:** 2015
4. **Description of technology with salient features:**

In Sikkim, all the agricultural operations are done by using bullock drawn traditional equipment. For secondary tillage, wooden leveller locally known as *dante* in Sikkim (**Fig. 1**) is used for clod crushing, levelling of field and puddling of rice field. Generally, 2-3 operations of *dante* are required for good seed bed.

Fig. 1 Traditional wooden leveller being used by the farmer for pudlling

In the improved design, the implement was fabricated with mild steel replacing the wood. Total 9 pegs made of 16 x 16 mm square and 145 length MS bar were fitted on a tool bar which stir the soil, break the clods and collect the traces. Handle was also modified from single "T" type to two handles "U" type. Based on the pulling capacity of local bullocks, the effective width of the machine was kept to 780 mm. A tool bar lifting device with three stage lift to adjust the peg length as per requirement was designed and fitted. The box section made of MS sheet which acts as planker was 800 x 190 x 80 mm. Transport wheels were provided for easy transportation of implement. The design of developed implement is given in (**Fig. 2**). The operation of the implement is same as in traditional tool. A pair of bullock pulls the implement. By the action of teeth, soil clods are broken, weed and crop residues are dragged which can be collected at the end of the field.





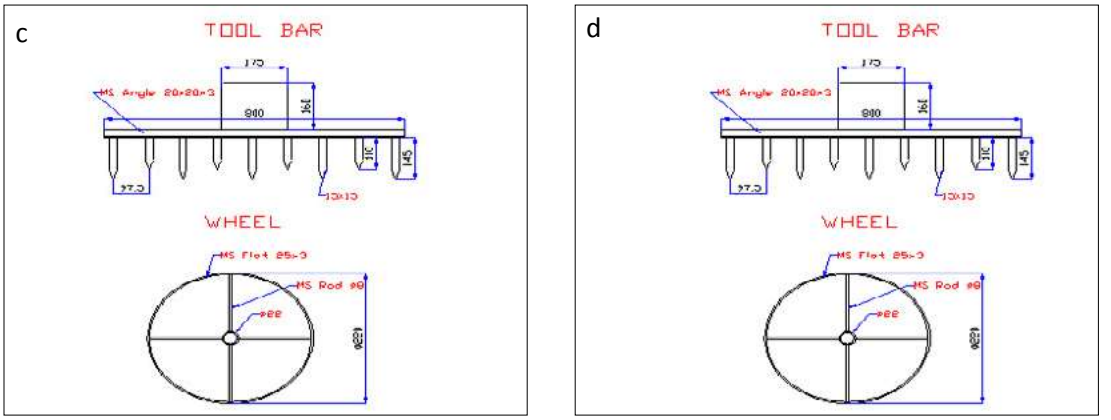


Fig. 2 (a to d) Computer aided manufacturing drawing of developed leveller cum planker

The machine was tested in the farmer's field (**Fig. 3**) and various operating and soil parameters were recorded and analysed. The land was ploughed using local plough two days before the use of equipment and soil moisture was 21% (db). Following results were obtained from the field testing; Working width: 800 mm. clod size by 63.81% in one pass at 21% (db) soil moisture. The work rate was 0.047 ha h^{-1} at 2.0 km h^{-1} as compared to 0.035 ha h^{-1} for local *dante*. The draft of the developed equipment was 48.0 kg against 52.0 kg in case of local *dante*.

Fig. 3 The developed leveller cum planker being operated in the farmer's field

5. **Critical inputs required:** A pair of bullocks to pull the implement; - One operator to operate the implement

6. **Observations to be recorded:** Draft; - Pulverization; - Work rate

7. **Target users/stakeholders:** MTTCs/KVKs/Farmers

8. **Precaution(s) with the technology:** The implement should be operated in the field at friable soil moisture (approximately 20% (dry basis) to get optimum pulverization. Also, the operating speed should be maintained at about 2.0 km h^{-1}

9. **Advantage/Benefits/Utility of the technology:** The work rate was higher by about 34% compared to traditional implement. Life span of implement is more as wood has been replaced by mild steel. The draft requirement is less by about 8%.

10. **Economics of the technology/ Benefit: Cost Ratio:** The fabrication cost of the machine was Rs 1000 (in 2015) and operating cost was about Rs 1400 ha^{-1}.

    Note: Benefit cost ratio may not be applicable for farm machines as it is one-time investment and there are many indirect benefits rather than direct benefits which cannot be assessed (for example,

ease operation, time saving, better quality of work, increase in yield due to timeliness etc.)

11. **Technology developed under the project:** Student research project.

12. **Investigator(s)/ inventor(s):** S. N. Yadav**:** Email: snyadavbpl@yahoo.com Mobile : 9933469544

13. **Technology publication(s):**

Yadav, S. N. and Malsawmdawngzuala (2016). Development of Animal Drawn Peg Planker for Secondary Tillage in Hill Agriculture. *Journal of Agricultural Engineering*, **53**(2): April – June 2016.

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TECHNOLOGY:
NECTAR-FM-90

1. **Name of the technology:** Mixed mode photovoltaic powered forced convection solar dryer
2. **Source of the technology:** CAEPHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2015
4. **Description of technology with salient features:**

This dryer is ideal for quick drying of agri produce which require augmented heating or for situations where the inherent moisture of the material is high requiring additional heating for drying. The developed equipment offers choice either as a combination of solar heating drying plus the forced hot air drying, or can also be used for drying using hot air alone where the quality of the material may deteriorate due to exposure to direct sunlight. Following are the characteristic features of the developed solar dryer:

- It is combination of direct and indirect solar dryers. Product may dry with both direct exposure to solar radiation and hot air supplier on it.
- The dryer had capacity to dry 10 kg of drying product. The solar dryer has total collector area of 0.9902 m^2 including 0.5002 m^2 of solar air collector area and 0.49 m^2 of drying area.
- The air can be circulated within dryer with the help of 12 V DC fan operated on 37 Wp solar PV module. It is recommended that the developed mixed mode photovoltaic powered forced convection solar dryer can be used for drying of agricultural and horticultural products, which reduces quality degradation over an extended storage period.
- The developed solar dryer provides a promising option for drying various agricultural and horticultural products in NEH region .It can be used to heat air up to the range 55-75 °C temperature needed for drying of most of the agricultural and horticultural products, efficiently and economically without compromising in quality of final product. Component wise specifications of dryer (**Fig. 1 & 2**) are given below:

Components	Specifications
Dimensions of drying chamber	
Height	900 mm
Width	700 mm
Solar collector area	490000 mm^2
Number of Trays	3
Number of exhaust fan	One
Diameter of Exhaust fan	10 mm
Inclination of solar cabinet	45°
Trays dimensions	
Upper Tray	660 mm × 540 mm

Middle Tray	660 mm × 480 mm
Lower Tray	660 mm × 240 mm
Dimensions of solar collector	
Length	1000 mm
Height	1 mm
Width	600 mm
Solar collector area	500200 mm^2
Number of Air inlet	One (10 mm × 8 mm)
Dimensions of orifice pipe	
Number of DC fan	One
Diameter	10 mm
Dimensions of stand	
Drying chamber stand height	700 mm
Front height of solar collector	5 mm
Inner height of solar collector	650 mm
Tilt angle of Air heater collector	37.23°

Solar collector and loading capacity per batch	
Aperture area	990200 mm^2
Orientation	Facing south
Loading capacity per batch	10 kg

Fig. 1. Schematic view of mixed mode photovoltaic powered forced convection solar dryer

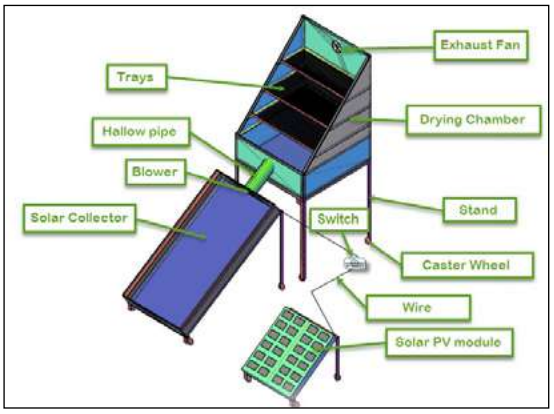

Fig. 2 View of mixed mode PV powered forced convection solar dryer

5. Critical inputs required:

GI sheet, glass wool, Solar PV module, MS angle, Glass sheet, Aluminum angle, aluminum mess, exhaust fan, wire, hot air oven, weighing balance, thermometer, lux meter

6. **Observation to be recorded:**

- Initial moisture content,%
- Final moisture content,%
- Weight of product, kg
- Ambient air temperature ,°C
- Dryer air temperature, °C
- Solar insolation,W m^{-2}

Target users/ stakeholders: Farmers/ MTTC/KVKs/Line department/Companies

8. **Precaution(s) with the technology:**

The solar collector and PV module should face south and be placed away from shadows of tress or buildings for outdoor. The solar collector and the recalculating duct should not be touched because of their temperatures. Gloves should be worn while taking out the trays from the drying chamber.

9. **Advantage/ Benefits/ Utility of the technology:**

The mixed mode photovoltaic powered forced convection solar dryer can be used for drying of agricultural and horticultural products, which reduces quality degradation over an extended storage period. The solar dryer can be effectively utilized as a promising option for drying various agricultural and horticultural products in NEH region. The developed solar dryer can be used to heat air up to the range 55-75 °C temperature needed for drying of most of the agricultural and horticultural products, efficiently and economically without compromising in quality of final product. The cherry pepper was dried within 24 hours from initial moisture content 82% to final moisture content about 10% w.b. under the mixed mode photovoltaic powered forced convection solar dryer.

10. **Economics of the technology/ Benefit: Cost Ratio:**

The benefit cost ratio and payback period of mixed mode photovoltaic powered forced convection solar dryer is 4.51 and 7 months respectively.

11. **Technology developed under the project:** Design and Development of Mixed Mode Photovoltaic Powered Forced Convection Solar Dryer funded by Central Agricultural University, Imphal, Manipur.

12. **Investigator(s)/inventor(s):**

M. S. Seveda**:** Email: sevda_mahendra@rediffmail.com; Mobile: 8972002379, 7908618953.

13. **Technology publication(s):**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 02: Technology No. 41: Mixed mode photovoltaic powered forced convection solar dryer, p. 75.

Seveda M. S. (2017). Renewable Energy Technologies for Sustainable Agriculture. Engineering Interventions for Sustainable Agriculture. M. S.Seveda, G. T.Patle and A. B.Sherpa (eds.). pp. 19-29, Biotech Books, New Delhi, ISBN 978-81-7622-407-9.

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TECHNOLOGY:
NECTAR-FM-91

1. **Name of the technology:** Low cost solar dryer
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Manipur
3. **Year of adoption/development:** 2015
4. **Description of technology with salient features:**

Traditionally the food products are dried by spreading in to thin layers in open sun. Though this method is economical and simple, yet it has many draw backs- *viz*., there is no control over the rate of drying, non-uniform drying, chances of deterioration and loss due to exposure of products to rain, dust, storm, birds, rodents, insects and pest etc. Solar drying system overcomes all such problems and ensures better quality of dried products, thereby fetching higher price for the dried products. A double rack solar dryer with forced convection was developed which consists of a transparent glass cover for transmitting solar radiation, aluminum trays (two numbers) for loading the produce, double wall made of GI sheet coated with dull black paint to absorb maximum solar radiation with thermocol/ glass wool as insulating materials embedded in between the sheets to minimize the thermal losses and a main cabinet made out of wood for housing different parts of the dryer. The transparent glass cover of thickness 4-5 mm is inclined at an angle of latitude of Manipur which is about 23°. Fresh air enters the cabinet through the holes made in the bottom of the dryer. The solar radiation falling on the dryer is transmitted by the transparent glass, which is absorbed by the absorber plate. Then the air gets heated and rises upwards as it becomes less dense. The hot air while moving upward removes the moisture from the product kept on the trays and exits through the holes made at the top of the dryer. The DC powered fan helps to exhaust the moist air in the chamber during the drying operation. The dryer saves 40% of drying time with superior quality dried products over open sun drying. (**Fig. 1**) shows the schematic diagram of the dryer while (**Fig. 2**) shows the drying of King Chili inside the dryer.

Materials and specification etc.:

- Raw material: Wood, G.I. sheet, Aluminum sheet, glass, wire mesh
- Weight: 80 kg
- Output capacity: 20 kg of horticulture produce dried per batch
- Overall dimension: 200 x 150 x 67 cm
- Prime mover: Manual
- Unit cost (per machine): Rs. 25,000
- Unit cost operation : Rs. 1.0-1.5 kg^{-1}

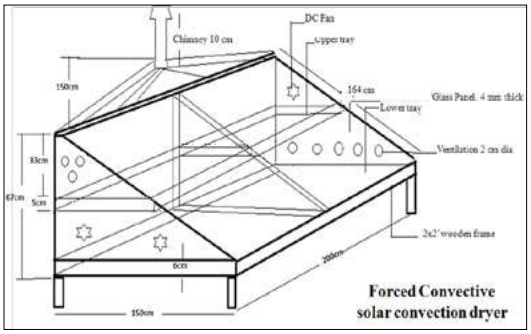

Fig. 1 Schematic Diagram of Solar Dryer

Fig. 2 Drying operation of Giant King Chilly in Solar Dryer

5. **Critical inputs/equipment/items required:** Low cost solar dryer, crops/commodity (fruits, vegetables, fish, medicinal plants, spices, etc.), man power (1 No.)

6. **Observations to be recorded:** - Inclination of glass panel for direct exposure to sun radiation

   - Time of drying of the particular commodity

   - Depth of materials on the drying tray

7. **Target users/stakeholders:** MTTCs/KVKs/Farmers/Agri-Entrepreneurs/Companies

8. **Precaution(s) with the technology:** During the drying operation, the glass panel should be oriented towards the southern side so as to allow the sun radiation to fall directly on the glass panel. The bed depth of the drying materials on the tray should be maintained in thin bed layer. Turning of the drying samples may be done once or twice during the entire drying period. The materials must be heaped and covered with a cloth on the tray during the night time. The glass panel must be always kept clean to obtain 100% transmissibility of solar radiation.

9. **Advantage/Benefits/Utility of the technology:** This system ensures uniform drying of products in the drying chamber. It saves about 40-50% of drying time with superior dried products over open sun drying.

   It could be easily fabricated in local workshop and is cost effective.

10. **Technology developed under the project:** IRP CAU Intra-mural Research Project, CAU, Imphal

11. **Investigator(s)/ inventor(s):** Ng. Joykumar Singh, P. T. Sharma and Y. Jekendra Singh: Email: joyngang@gmail.com, Mobile: 9612168301

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TECHNOLOGY:
NECTAR-FM-92

1. **Name of the technology:** Low cost portable zero energy cooling chamber
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Manipur
3. **Year of adoption/development:** 2015
4. **Description of technology with salient features:**

This cooling chamber is based on the principle of evaporative cooling and therefore, better cooling effect is achieved when the ambient temperature is high and relative humidity is low. During storage inside the cooling chamber, the temperature of the stored food products is lowered by 4-10°C in comparison to the ambient temperature, thus the shelf storage life is increased. This low cost portable zero energy cooling chamber was primarily designed to be portable so that freshness of fruits, vegetables and other food items can be maintained for longer period of time both, in stationary storage condition as well as while in transportation. It consists of a metallic rectangular frame with aluminum sheet around the internal walls. The outer surfaces of the four walls are covered with woven wire mesh. Saw dust is filled in the spaces between the internal aluminum wall and the wire mesh. The saw dust is kept continuously wet by regular application of water. Fruits and vegetables are stored in plastic baskets inside the cooling chamber. Bottom of the inner chamber is provided with a layer of the thrmocole to minimize exchange of heat between the outside atmosphere and inside of the cool chamber. The top is covered with a lid having thermal insulating material so that the internal cool chamber is not in direct contact with hot atmosphereoutside. (**Fig. 1**) shows the cross-sectional view of the developed cooling chamber while (**Fig. 2 & 3**) respectively show the developed cooling chamber and fruits and vegetables stored inside the cooling chamber.

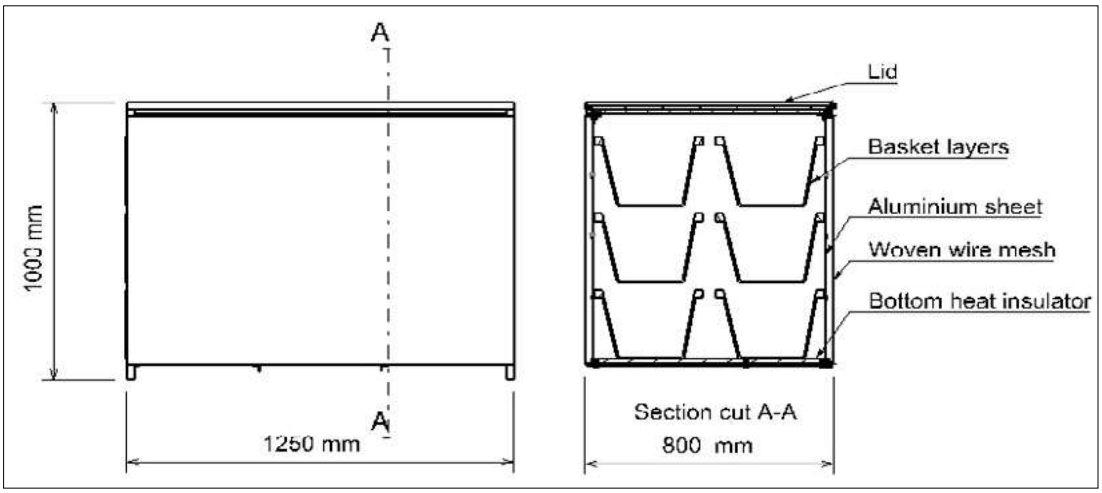

Fig.1 Cross sectional view of cooling chamber

Fig. 2 Portable zero energy cooling chamber

Fig. 3 Stored fruits & vegetables inside the cooling chamber

Material and specification of the chamber:

a) Material: MS angle bar (25 x 4 mm), MS sheet (20 gauge), Aluminum sheet (20 gauge, 30 gauge), woven wire mesh, saw dust (0.11 cum)

b) Specifications:

- Overall dimension : 125 x 80 x 100 cm (l x b x h)
- Weight : 42 kg
- Prime mover : Manual
- Storage capacity : 0.80 cum
- Unit cost (per machine) : Rs.5,000 (Approximate)
- Efficiency : 4-10 ^{0}C less than room temperature
- Unit cost operation : Nil
- Suitability for crops/commodity: Fruits, vegetables, medicinal plants, spices, flowers etc.

5. **Critical inputs/equipment required:** Cooling chamber, plastic trays, plastic boxes, raw materials to be kept etc.

6. **Observations to be recorded:**
   - Inside and outside temperature
   - Extended shelf life of the stored produce

7. **Target users/ stakeholders:** KVKs/ Farmers/ transporters/retailers/ domestic users

8. **Precaution(s) with the technology:** During the storage period, the saw dust which is filled in the outside body of the cooling chamber should be wetted all the time. Therefore, regular application of water is required. Very high humidity inside the chamber tends to accelerate rotting of the stored produce and hence, prevention of accumulation of water in the inside of the cooling chamber is required as far as possible. Minimizing direct contact of inside cool atmosphere with the outside hot atmosphere during storage is necessary. Frequent opening of the top cover lowers the effectiveness. There should not be compaction of the stored food produce. Separate food items should be loosely stored in separate containers.

9. **Advantage/ Benefits/ Utility of the technology:**

   Large amount of fruits and green vegetables are produced at various farm

conditions. Larger percentage of these produce are wasted in terms of quantity and quality before reaching to the customer due to unavailability of proper low-cost storage facility at farm level and during different stages of marketing.

This cool chamber can be used for keeping the produce in fresh condition for longer duration at the farm itself during harvesting, on carriages during transportation, at retail shop for storage at marketplace etc. Cabbage, cauliflower, tomato and grapes could be stored in the cooling chamber upto 20 days in fresh condition with less than 20% loss in terms of quantity. This also will be suitable for short term storage of food items for domestic purpose where there are no other better facilities. This will enable to reduce monetary loss during post-harvest and transportation of fruits and vegetables and also will help in making fresh food items available to the end user. This portable zero energy cool chamber can be fabricated by local artisans with raw materials available locally.

10. **Technology developed under the project:** IRP CAU Intra-mural Research Project, CAU, Imphal

11. **Investigator(s)/inventor(s):** P. T. Sharma and Ng. Joykumar Singh: Email: ptsharma4@gmail.com.

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TECHNOLOGY:
NECTAR-FM-93

1. **Name of the technology:** Improved *Kokcheng (bamboo basket)*
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2015
4. **Description of technology with salient features:**

Rural women of Meghalaya traditionally use "*kokcheng*" (**Fig. 1**) a locally made bamboo basket to carry firewood, where there is a rope made with bark of *Omak* tree (local name), which is available in Garo Hills. Such type of rope is very strong to give support to loaded *kokcheng* but at the same time it is very hard and rough to user's body. Therefore, a new type of *kokcheng* was was developed where a new belt is attached which is a kind of thickly woven cotton belt with adjustable buckle. This belt is very much user friendly as during the time of carrying firewood, tribal rural hilly women found it very comfortable to their body and easy to handle due to adjustable buckle according to their body anthropometry. Traditionally, the basket was hanging from head. Now added support is given from two shoulders with belt so that weight or strain on head can be decentralized to shoulders of users. Therefore, this modified basket with developed attachments (**Fig. 2**) is considered as user friendly by rural women and is recommended to women firewood collectors for use instead of traditional one. This basket can be used by hill area women not only for firewood, but can also be used to carry water pot, vegetables etc. for their day to day activities. (**Fig. 3 to 6**)

Specification of *Kokcheng*:

- Height – 43 cm
- Diameter (Top) – 48 cm
- Size of bottom – 18 x 18 cm
- Width of adjustable belt – 4 cm
- Size of head support – 7.5 x 24 cm
- Size of shoulder support – 7 x 50 cm

Impact on ergonomic cost

Ergonomic Parameters	% Reduction in Ergonomic Cost over traditional *Kokcheng*
Heart Rate (b/min)	5.59
Energy Expenditure ($Kjmin^{-1}$)	9.75
Rated Perceived Exertion	27.78
Lower Back Pain	22.68
Head Pain	19.59
Neck Pain	22.45

5. **Critical inputs/ equipment/ items required:** Bamboo basket, woven cotton belt, sponge, thick cotton fabric, buckle and metal rings.
6. **Observation to be recorded:** NA
7. **Target users/stakeholders:** Farm women and men
8. **Precaution(s) with the technology:** Belt should be thickly woven

Fig. 1 Traditional *kokcheng* with rope made with Omak tree skin

Fig. 2 Required attachments for improved *kokcheng*

Fig. 3-6 Improved *kokcheng* with head and shoulder support

9. **Advantage/Benefits/Utility of the technology:** This user and ecofriendly Improve *Kokcheng* can be used to carry firewood, water pot, vegetables, paddy, fodder, castor leaves for silkworms, day to day items etc. with less pressure on back and neck which will lead to reduction of drudgery.

10. **Economics of the technology/ Benefit:** Cost Ratio: Rs. 450 per unit

11. **Technology developed under the project:** Developed under Intramural Research Project on "Drudgery Reduction of Farm Women of Meghalaya involved in Household Activities Through Technology Intervention" funded by CAU, Imphal.

12. **Investigator(s)/inventor(s):** Swapnali Borah; Email: swapnali70@yahoo.com; Mobile: 9089706800

13. **Technology publication(s):**

Borah, Swapnali (2016). Improved *Kokcheng* (bamboo basket)–for hilly tribal women of Meghalaya. *CAU Research Newsletter,* **7**(2): 5. ISSN: 2319-3042.

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TECHNOLOGY:
NECTAR-FM-94

1. **Name of the technology:** Improved harnessing system of domesticated Mithun for utilization in agriculture (YOKE)
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2016
4. **Description of technology with salient features:**

- The traditional wood log yoke with weight of 13 kg, (**Fig. 1**) was found to be in use for cultural operations using Mithuns in NRC on Mithun farm Medziphema, Nagaland which was less efficient and un- comfortable to animals due to heavy weight and its improper grip on animal shoulder. Therefore, a special yoke needed to be developed for Mithun. The observations recorded on body dimensions and physiological parameters of Mithuns for draught ability assessment at ambient conditions (temperature 17^0 C and 63% relative humidity) were used to develop this technology. The range of body length of Mithun varies from 1270 to 1355 mm with neck size of 740 to 805 mm. The height of hump varies from 280 to 380 mm and length of 220-380 mm. Based on these observations a light weight special yoke, made of local wood of Sikkim, was fabricated having the size :of length = 1981.2 mm, width= 101.6 mm, and thickness = 152.4 mm and with proper grip to harness Mithuns as draught animal (**Fig. 2**). Proper yoking systems gives better draft output and provides comfort to the animal.
- The theoretical field capacity, actual field capacity and field efficiency of this equipment are 0.0396 ha h^{-1}, 0.0266 ha h^{-1} and 67.17%, respectively.
- The average draft of wedge of plough are 589.8 N at the operating depth of 147.5 mm and average speed 1.98 kmph (0.55 ms^{-1}). Mithun could develop draft force of 11.80% of his body weight for continuous farm

Fig. 1 Traditional wood log yoke (weight 13 kg)

Fig. 2 Light weight improved special yoke (weight 6.5 kg)

Fig. 3 Improved wedge plough

Field Trials: A study was conducted at National Research Centre Farm, Medziphema, Jharnapani, Nagaland. to measure the draft force requirement of improved wedge plough developed by CAEPHT Centre Ranipool, Gangtok through Special yoke and Mithun pair (weight 506 kg) as draught animal. The results of this study are presented in **Table 1**.

Table 1 Field performance evaluation of wedge plough using Mithun as draught animal

Sl. No.	Parameters	Average Values
1.	Area of test filed, m^2	1200
2.	Weight of plough, kg	9.5
3.	Length of line of pull (L), mm (**Fig. 4**)	2500
4.	Height of hitch (H), mm	1000
5.	Height of horizontal component of pull from ground (h), mm	250
6.	Angle of inclination (θ)	17.450*
7.	Cos θ	0.954
9.	Average pull, unit to be mentioned	618.3
10.	Draft, N	589.8
11.	Average width of ploughing (W), mm	200
12.	Average depth of ploughing (d), mm	147.5
13.	Average Speed of operation (s), km ph	1.98
14.	Time taken in ploughing operation, min	225
14.	Total time lost (time spent in turning at head land + time spent for others reasons), min	45
16.	Theoretical field capacity, ha h^{-1}	0.0396
17.	Actual field capacity, ha h^{-1}	0.0266
18.	Field efficiency, %	67.17

5. Critical inputs required:

- Special Yoke
- Wedge plough
- Animal: A pair of Mithun
- Labour/Operator: one

6. Observations to be recorded:

- Area of test filed, m^2
- Weight of plough, kg
- Length of line of pull (l), mm
- Height of hitch (h), mm
- Height of horizontal component of pull from ground (h), mm
- Angle of inclination (θ)
- Cos θ
- Average pull
- Draft, N
- Average width of ploughing (W), mm
- Average depth of ploughing (d), mm
- Average Speed of operation (s), km ph

- Time taken in ploughing operation, min
- Total time Lost (time spent turning at head land+ time spent for others reasons), min
- Theoretical field capacity, ha h^{-1}
- Actual field capacity, ha h^{-1}
- Field efficiency, %

7. **Target users/ stakeholders:** MTTCs/ KVKs/ Farmers/ innovators

8. **Precaution(s) with the technology:** To avoid decay of special yoke keep in dry and closed space after use. Yoke should be used with proper adjustment on the neck of the trained mithun.

9. **Advantage/ Benefits/ Utility of the technology:** The farmers rearing domesticated mithuns could use the developed yoke to provide comfort and safety to Mithuns with proper grip around neck during tillage operation in Nagaland.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 1.2

11. **Technology developed under the project:**

    ICAR-AICRP on UAE Centre of CAEPHT (CAU), Gangtok, Sikkim.

12. **Investigator(s)/ inventor(s):** S. K. Chauhan**:** Email:chauhansujeetkumar@gmail.com; Mobile: 8436711386

13. **Technology publication:**

Fig. 4 Test trial of special yoke by using Mithun pair at NRC on Mithun farm Medziphema Jharnapani, Nagaland

Tiwari, R. K., Chauhan, S. K. and Singh, Y. Jekender (2018). Evaluation of Improved Yoke and Harnessing Systems Using Domesticated Mithuns (*Bos frontalis*) for Seedbed Preparation – A Case Study in Nagaland. *Agricultural Engineering Today*, **42**(3): 28-34. (ISSN: 0970-2962).

Chauhan, S.K., Yadava, S. N. and Srivastava, P. K. (2016). Efficient utilization of draught animal in crop-livestock integrated farming system for small and marginal farmers of NEH. *CAU Souvenir-Regional Agri. Fair*, February 3-5, 2016: 73-78.

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TECHNOLOGY:
NECTAR-FM-95

1. **Name of the technology:** Power operated hold-on type paddy thresher
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Gangtok, Sikkim
3. **Year of adoption/development:** 2016
4. **Description of technology with salient features:**

Threshing of paddy is a labour intensive and time-consuming operation. Threshing of paddy in NEH region in general and Sikkim in particular is done manually by beating the crop on a hard surface or by animal trampling. Small sized mechanical threshers for small farmers of Sikkim is therefore needed to be developed. Therefore, a small hold on type power thresher for paddy crop was developed with the above objective. The thresher consists of a wire-loop type threshing cylinder, aspirator blower, oscillating sieve shaker, electric motor and power transmission system. In the machine, the crop in small bundles is pressed against the threshing cylinder for threshing.

The developed thresher (**Fig. 1 & 2**) is an improvement over the available pedal operated paddy threshers. In this improved thresher, threshing and cleaning of grain can be done simultaneously. The thresher has been extensively tested in farmer's fields (**Fig. 3 & 4**) and the performance was found satisfactory. The thresher has a threshing and cleaning efficiency of 98.21% and 95.4%, respectively. The capacity of the thresher was found to be 96.7 kg grain h^{-1} or about 200 kg crop h^{-1}. The cost of the machine is about Rs. 30,000 and it weighs only 165 kg. Two persons are needed to operate the thresher, one for material handling and one for feeding the crop in to the machine.

Particulars	Value/description
Prime mover	Single phase 1.5 hp electric motor
Cylinder type	Wire loop
Cylinder dimension (diameter × length)	500 × 500 mm
Blower type	Centrifugal radial fan type
Blower dimension (diameter × width)	500 × 140 mm
Cylinder speed, rpm	450
Blower speed, rpm	450
Sieve shaker frequency	480 strokes m^{-1}
Sieve stroke length	25 mm
Weight of thresher	165 kg

Fig. 1 Stationary view of the developed power paddy thresher

Fig. 2 Stationary view of the developed power paddy thresher

Fig. 3 View of the power thresher in operation

Fig. 4 View of the clean paddy received at the grain outlet

6. **Critical inputs required:**

- single phase, 220 V electric supply
- Extension wire for electrical supply
- Operator 2 nos.
- Harvested paddy crop to be presented in small bundles (it may be placed in machine, not presented, please cheque)

6. **Observations to be recorded:**

Threshing efficiency, cleaning efficiency, total grain loss and grain output

7. **Target users/ stakeholders:** Farmers, MTTCs/ KVKs/ Line department/ Companies & machine/ implement manufacturers

8. **Precaution(s) with the technology:** The operator must be trained in handling of the machine. The operator should be extremely attentive while feeding crop in the machine. The operator hand should not cross beyond the feeding platform. The crop should be sun dried before threshing.

9. **Advantage/ Benefits/ Utility of the technology:** 1: 1.2

10. **Technology developed under the project:** All India Coordinated Research Project on Farm Implements and Machinery

11. **Investigators/ inventors:**

    S. K. Satpathy: Email: sangramkishorsatpathy@gmail.com Mobile: 9475710905.

12. **Technology publication:**

    Satpathy, S. K. (2017). Progress Report of AICRP (FIM) CAU-Gangtok center, presented in XXX I annual workshop of AICRP (FIM) at TNAU Coimbatore, January 3-5, 2017.

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TECHNOLOGY:
NECTAR-FM-96

1. **Name of the technology:** Filtration units for natural streams for reducing the sediment load in natural ponds/tanks
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2016
4. **Description of technology with salient features:**

In north-eastern states of India, water for irrigation is mostly diverted or lifted from surface water bodies such as streams, ponds, and tanks. Because of the basic geology of the region, these water bodies remain extremely turbid (**Fig. 1a**). It is a major obstruction in the promotion and adaptation of drip irrigation system, since it frequently chokes its filtration unit (reported to Principal Investigator by the farmers from Manipur). Moreover, siltation also reduces the capacity of the ponds/tanks. Wherever, the natural streams (specifically during monsoon season) are tapped and guided to fill the natural ponds or artificial tanks, filtration is required. For this purpose, a very low-cost filtration unit has been developed (**Fig. 1b**). Its constructional details are presented in the (**Fig. 2)**.

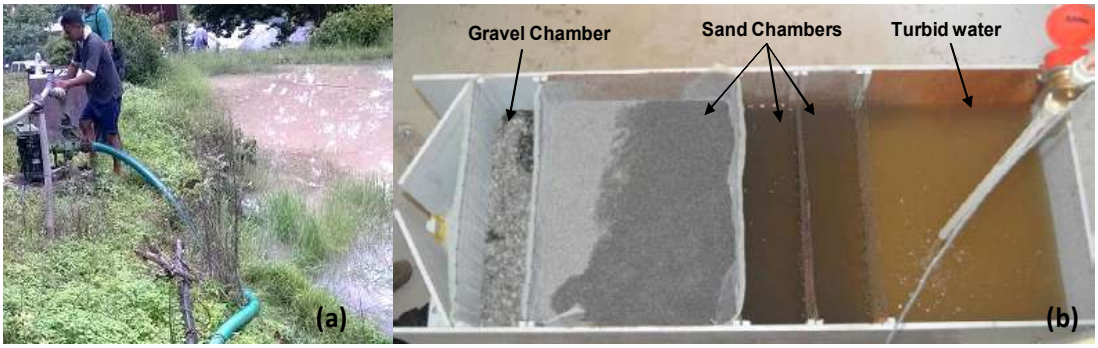
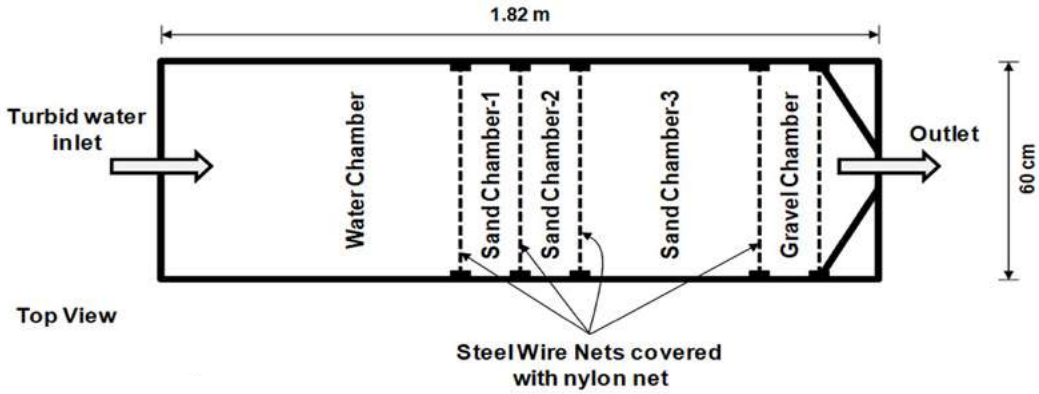


Fig. 1(a) A view of pond having extremely turbid water in Andro Farm, CAU Imphal, Manipur,
(b) Top view of the developed filtration unit



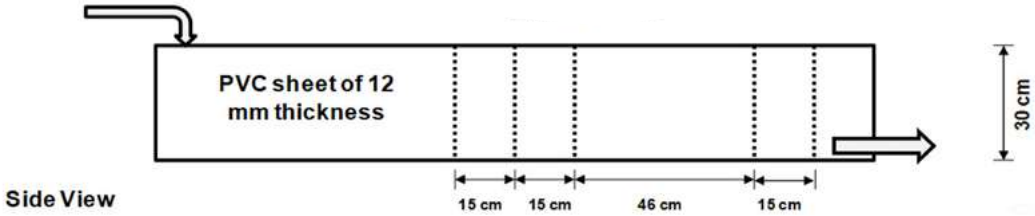


Fig. 2 Constructional details of the developed filter

Adaptability of the technology: In **Fig. 1a & b**, the constructional details of the experimental filtration unit are provided. However, farmers can construct a very low-cost filtration unit of desired dimensions in the field itself with the use of sand, bamboo and mosquito net. Only concern is to allow the turbid water to pass through the sand wall (not bed) that will be retained by the mosquito net supported by the bamboo and boulders. Size of the filtration unit will depend upon the size of the stream.

5. **Critical inputs required:** Raw material as mentioned in the previous paragraph are required.

6. **Observation to be recorded:** Turbidity (if possible).

7. **Target users/stakeholders:** Farmers are the actual stakeholders of the technology. In the initial stages, the role of MTTC, KVKs, and line departments is required to promote and to provide technical guidance to the farmers.

8. **Precaution(s) with the technology:** The service life of such filtration units solely depend upon the cleaning of sand wall. Reduction in filtration rate will indicate the time for its cleaning.

9. **Advantage/ Benefits/ Utility of the technology:**

   a. It assists in increasing the service life of the filtration unit of the drip irrigation system by removing the majority of foreign matter (organic/inorganic) present in the natural water body.

   b. If the filtration unit is constructed across the natural stream, it will drastically decrease the siltation of pond/tank and will retain its capacity.

10. **Economics of the technology:** There is a need to purchase only mosquito net from market (10-20 INR m^{-1}) as other materials are available locally or at very cheap rates. Depending upon the flow rate of the drip irrigation, the market price of its filtration unit starts from Rs. 2500 and may range up to Rs. 8000. By adopting the proposed technique, the farmers can save this mentioned amount in every growing season.

11. **Technology developed under the project:** The technology is developed under the CAU Imphal funded IRP project entitled "Impact of Particle size distribution of filter material on water turbidity and flow rate for use in drip irrigation and groundwater recharge".

12. **Investigator(s)/inventor(s):** A. K. Vashisht, E-mail: akvashisht74@gmail.com; Mobile: 7908158001

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TECHNOLOGY:
NECTAR-FM-97

1. **Name of the technology:** Portable manual mulch laying machine for hill terrace
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2016
4. **Description of technology with salient features:**

   Plastic mulch helps reduce evaporation and conserve moisture, increases soil temperature, and keeps control on the weeds. It is a proven means of modifying the micro environment around a vegetable crop. Portable manual mulch laying machine is quite useful in laying plastic mulch quite easily with help of two persons. The machine, with following details, can be easily carried from one hill terrace to another by a progressive farmer.

- The portable manual mulch laying machine for the convenient mulch operation and benefit for the farmers in the hill areas was fabricated at CAEPHT, Ranipool Workshop.
- The two furrow openers made up of MS flat (**Fig. 1**) are attached to the machine for soil inversion and firm placement of mulch plastic sheet from the two ends along the length of the plastic sheet.
- A plastic sheet roll carrier and a handle for manual pulling of the machine are other important machine attachments.
- In its testing inside the poly house (**Fig. 2**), it was observed that the soil inversion was satisfactory i.e. sufficient soil was turned on to the plastic mulch sheet, besides a very good unrolling and laying of the plastic mulch sheet.

Size/ Dimensions of the machine	Length: 1.75 m; Width: 1.4 m
Width of mulch sheet	1.2 m
Material of fabrication	Iron (MS) frame
No. of furrow openers	Two
Operation	Manual pulling
Machine cost	Rs. 2,500

Fig. 1 Manual mulch laying machine fabricated at AICRP-PET, CAE & PHT, Ranipool

Fig. 2 Manual mulch laying machine after satisfactory operation

5. **Critical inputs required:**

- 30-micron plastic black-silver mulch
- Manual mulch laying machine

6. **Observation to be recorded:**

   In its testing inside the poly-house, it was observed that the soil inversion was satisfactory. Sufficient soil was turned on to the plastic mulch sheet, besides a very good unrolling and laying of the plastic mulch sheet.

7. **Target users/stakeholders:** MTTC/ KVKs/ Line department/Companies

8. **Precaution(s) with the technology:** Seed treatment, line sowing on drip irrigation system and need based application of insecticides and pesticides. When the crop is raised in low tunnels, the polythene should be removed during day time with the initiation of pistillate flowers for pollination. The plastic mulch (30 microns) should be carefully put in the roll without any mechanical tear of film. Injury should be avoided while assembling the mulch laying machine after putting the roll of plastic mulch in the hill terrace.

9. **Advantage/ Benefits/ Utility of the technology:** The use of portable manual plastic mulch laying machine will assist in reducing the drudgery in laying the plastic mulch in the terraces at much faster rate through manual laying machine in comparison to the manual operation of laying the plastic mulch.

10. **Economics of the technology/Benefit: Cost Ratio:** The use of plastic mulch has led to the increase in total income of farmers due to higher yields and better-quality vegetables or fruits in comparison to the cultivation without plastic mulch. A progressive farmer of a model village adopted by the AICRP on Plasticulture Engineering Technology in East Sikkim under 'Mera Gaon Mera Gaurav' reported rise in yield of tomato (Romeo) grown in naturally ventilated poly house under organic management practices from 4 kgm^{-2} (without mulch) to 6 kgm^{-2} (with plastic black silver mulch). The plastic mulch film may be reused for three to four season crops. The use of plastic mulch will increase the cost of production for a given crop because of money spent in purchasing plastic mulch and mulch laying machine. The rising production cost is offset by increased income of farmers from earlier harvests, higher yields, and better-quality vegetables to create an economic advantage for the use of plastic mulch and portable mulch laying machine by progressive farmers in hill terraces.

11. **Technology developed under the project:** ICAR-All India Coordinated Research Project on Plasticulture Engineering Technology, Dept. of Soil and Water Conservation Engineering, CAE&PHT, CAU, Sikkim.

12. **Investigators/ inventors:** Kh. Lily Devi, S. R. Yadav and Deepak Jhajharia: E-mail: lilykhwai@gmail.com; Mobile: 7602684826.

13. **Technology publication:**

Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 02: Technology No. 37: Development of Portable manual mulch laying machine for hill terraces,73-74 pp.

Jhajharia, D. and Devi, Kh. L. (2018). Plastic Mulch-Baat FasalKo Uatpaadan. Extension Bulletin in Nepali, CAEPHT, CAU, 1-6 pp.

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TECHNOLOGY:
NECTAR-FM-98

1. **Name of the technology:** Solar biomass hybrid dryer for large cardamom drying
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2017
4. **Description of technology with salient features:**

Drying of large cardamom is an important step which determines the marketable value of the product. Under drying deteriorates the product quality as the capsules get infected by molds while over drying reduces the quality as the volatile oils possibly get lost. So right drying is very important, soon after the harvest of the economic product. The general method of drying is using wood-base furnaces which involve high cost on account of cost of fire wood, besides the over drying that may happen during the processing. Use of solar energy therefore is an effective means for the large cardamom processing.

The solar biomass hybrid dryer consisting of a solar collector, a down draft biomass gasifier and a drying chamber (**Fig. 1 & 2**) was designed and developed with drying capacity of 20 kg batch^{-1} of large cardamom. The solar biomass hybrid dryer with total solar collector area of 1.25 m^2 is capable of drying 20 kg of large cardamom. The length and breadth of the solar collector is 1.6 m and 0.8 m, respectively. A down draft gasifier having a capacity of 8.67 kg batch^{-1} is designed which was capable of drying 17.34 kg of large cardamom. The drying chamber of solar-biomass hybrid dryer consists of 5 trays each of having an area of 0.3 m^2. A chimney of 10 cm diameter and 0.70 m height is provided at the top of the drying chamber for the moisture removal. The large cardamom could be dried from initial moisture content 80% (w.b.) to 10% (w.b.) within 20 hours in the developed solar-biomass hybrid dryer. The drying rate varies between 0.4 kg h^{-1} to 0.6 kg h^{-1} in the developed solar-biomass hybrid dryer. The results revealed that the drying efficiency of developed solar-biomass dryer was found 35.84%. The solar-biomass hybrid drying, the required moisture content of 10% was achieved within 20 h.

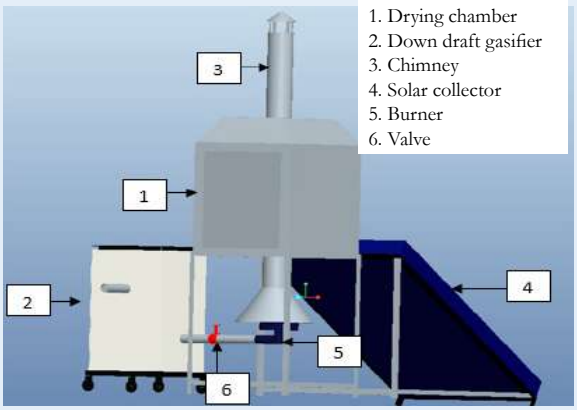

Fig. 1 Schematic view of solar-biomass hybrid dryer for large cardamom drying

Fig. 2 View of solar-biomass hybrid dryer for large cardamom drying

5. **Critical inputs required:**

GI sheet, glass wool, MS sheet, MS angle, Glass sheet, Aluminum angle, aluminum mess, exhaust fan, wire, hot air oven, weighing balance, thermometer, lux meter

6. **Observation to be recorded:**

- Calorific value of biomass, kJ kg^{-1}
- Bulk density of biomass, kg m^{-3}
- Gasification efficiency, %
- Specific gasification rate, kg m^{-2} h
- Biomass consumption rate (BCR), kg h^{-1}
- Initial moisture content, %
- Final moisture content, %
- Weight of product, kg
- Ambient air temperature,°C
- Dryer air temperature, °C
- Solar insolation,W m^{-2}

7. **Target users/stakeholders:** Farmers/ MTTC/ KVKs/ Line department/ Companies

8. **Precaution(s) with the technology:**

The orientation of solar collector and PV module should be south facing. The solar collector and PV module should be placed away from shadows of tress or buildings for outdoor. The solar collector and the recirculating duct should not be touched because of their temperatures. Gloves should be worn while taking out the trays from the drying chamber.

9. **Advantage/ Benefits/ Utility of the technology:**

The solar biomass hybrid dryer is suitable for small scale large cardamom farmers in rural areas of the countries. The solar-biomass hybrid dryer is capable of attaining a maximum temperature a maximum temperature of 66.6°C in solar mode and 70°C in the gasifier mode of operation. The large cardamom having an initial moisture content of 82.3% could be dried to a moisture content of 10% within 20 hours. The average solar collector efficiency of developed solar-biomass hybrid dryer for drying of large cardamom is 35.39%. The average gasifier efficiency and combustion efficiency of solar-biomass hybrid dryer for drying of large cardamom is 71.57% and 55.36% respectively. The solar-biomass hybrid dryer is able to reduce the drying time and increase the product quality in comparison to traditional bhatti and open sun drying.

10. **Economics of the technology/ Benefit: Cost Ratio:**

The net saving of biomass for solar-biomass hybrid dryer was about 90% in comparison to the traditional bhatti. The Payback period and cost benefit ratio (B:C ratio) of solar-biomass hybrid dryer for drying of large cardamom was 2 years of operation and 4.1, respectively.

11. **Technology developed under the project:**

Solar Biomass Hybrid Dryer for Large Cardamom Drying funded IRP of Central Agricultural University, Imphal, Manipur.

12. **Investigator(s)/inventor(s):**

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13. **Technology publication(s):**

Seveda, M. S. (2017). Renewable Energy Technologies for Sustainable Agriculture. Engineering Interventions for Sustainable Agriculture, M. S. Seveda, G. T.Patle and A. B.Sherpa (eds.), pp. 19-29, Biotech Books, New Delhi, ISBN 978-81-7622-407-9.

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TECHNOLOGY:
NECTAR-FM-99

1. **Name of the technology:** Light weight self-propelled zero till multi-crop planter

2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim

3. **Year of adoption/development:** 2017

4. **Description of technology with salient features:**

For hilly tracts of NER, powered assisted equipment, animal drawn implements and light weight power tiller have shown greater relevance for increasing the mechanization. Keeping in view of above, a self-propelled light weight walks behind type multi-crop planter (**Fig. 1**) was designed and developed for sowing of pea, buckwheat and mustard under zero till condition in two rows at a time. A 2.1 kW petrol engine was used to give the power to the machine. The row to row spacing is adjustable. By changing the seed plate, different crops can be planted. Weight of the machine is about 42.0 kg and it can be shifted from one terrace to other. The computer Aided Design with specification is shown in **Fig. 2**. An operator controls the machine and moves forward by engine power. The seed is filled in the seed hopper which is dropped by seed metering system. Seed to seed spacing is fixed in design itself and row spacing can be adjusted as per requirement. The machine was tested in the farmer's field (**Fig. 3**) for sowing of pea under zero till condition after harvest of paddy. The performance of the machine was as under;

- It is self-propelled machine fitted with 2.1 kW gasoline engine.
- The planter is suitable for planting of pea, buckwheat, mustard and other crops under zero till condition in two rows.

Fig. 1 View of developed zero till self-propelled light weight multi crop planter

- The row spacing is adjustable between 300 to 400 mm. The average forward speed of the machine was 1.0 to 1.5 km h^{-1}. Average depth of sowing was 35 to 40 mm.
- The work rate of the machine is about 0.06 ha h^{-1} (about 16 h for 1 ha) and sowing cost was about Rs. 2000 ha^{-1}.
- The cost of the equipment: Rs 35,000

5. **Critical inputs required:**

- Petrol and lubricant
- One Operator
- Seed to be sown

6. **Observation to be recorded:**

- Speed of operation, km h^{-1}
- Row to row spacing, mm
- Actual field capacity, ha h^{-1}
- Missing hills
- Average depth of sowing, mm
- Average seed to seed spacing, mm
- Seed rate, kg ha^{-1}

Target users/stakeholders: Farmers

8. **Precaution(s) with the technology:**

- The field should be free of crop residue and weed

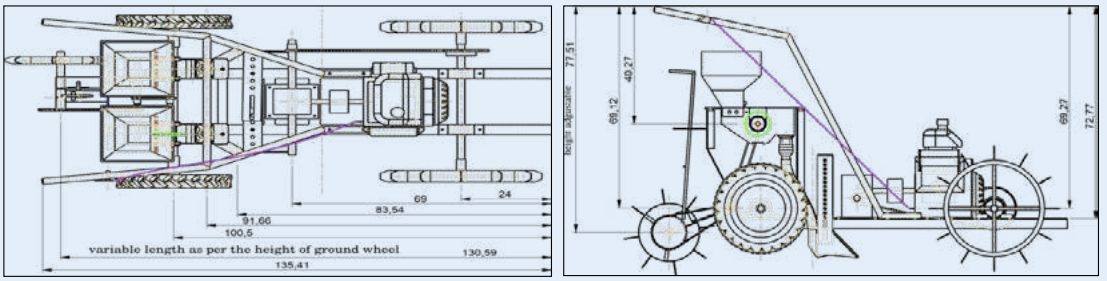

Fig. 2 Computer aided design of planter showing specification of planter by plan and side view

Fig. 3 Field testing of developed planter (left) and pea crop sown by planter (right)

- At the time of sowing, soil moisture content should be around 25% (db)
- There is chance of choking of furrow openers. Therefore, it should be checked from time to time

9. **Advantage/Benefits/Utility of the technology:** The machine is suitable for zero till planting in terraces. One ha area can be planted in approximately two days

10. **Economics of the technology/ Benefit: Cost Ratio:** The cost of the machine is about Rs 35,000 (in year 2017). The sowing cost is Rs 2000 ha^{-1}.

11. **Technology developed under the project:**

    ICAR sponsored project on "Development of Equipment and Technology to Mechanize Conservation Agriculture (CA) on Terraces under Rainfed Hill Farming Condition of NEH Region".

12. **Investigator(s)/inventor(s):** S. N. Yadav, S. R. Yadav, and A. B. Sherpa**:** Email: snyadavbpl@yahoo.com; Mobile: 9933469544

13. **Technology publication(s):**

Yadav, S. N., Bhattacharjee, A. and Sailo, Saihmingliana (2016). Design and development of mechanically powered light weight zero- till multi crop planter suitable for terrace farming. *Life Sciences International Research Journal*, **3**(1): 5-8. ISSN: 2347-8691, ISBN: 978-81-928281-73-1.

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TECHNOLOGY:
NECTAR-FM-100

1. **Name of the technology:** Self-propelled crop residue mulcher cum weeder
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2017
4. **Description of technology with salient features:**

Under zero till cultivation practice, before sowing of next crop, it is necessary to clear the field from crop residues and weeds to facilitate the zero till drill function smoothly. Manual cleaning takes long time. Though, brush cutters are available but they are not ergonomically comfortable. A self- propelled small crop residue mulcher cum weeder was therefore, developed to cut residues and clean the field before zero till planting. To design and develop the machine, a 1.0 kW, 4 stroke, 3500 rated speed, vertical shaft gasoline engine was mounted on the frame. The power from the engine was taken to a worm and pinion type gear box having 30:1 reduction ration through centrifugal clutch. The power from the gear box was given to transport wheel and mulching unit through chain and sprocket and belt and pulley respectively. A curved shape blade was cut from saw blade made of high carbon steel and was fitted as cutting unit. The developed machine is shown in (**Fig. 1**). The machine was tested in the field (**Fig. 2**) to test its performance.

Fig. 1 Developed self-propelled mulcher cum weeder

Fig. 2 Self-propelled mulcher being used in field for cleaning of paddy residue

The field performance of the machine was as under:

- It is suitable for cutting of crop residue before zero tillage sowing and can also be used for weeding in wide row spacing crops.
- The work rate is about 0.36 hah^{-1} (approximately 3 h to clean one ha area).
- It can cut the crop residue/weed just about the ground surface depending up on the skill of operator.
- The size of the blade was 115 mm and

working width 400 mm. However, both these parameters are adjustable according to the requirement.

5. **Critical inputs required:**

- Petrol and oil for lubrication
- One operator

6. **Observation to be recorded:**

- Crop residue height and quantity before and after of operation of machine
- Work rate
- Height of cut

7. **Target users/stakeholders:** MTTCs/ KVKs/Farmers

8. **Precaution(s) with the technology:** The cutting blade is open and circular speed is very high. The cut residue and small quantity of cut soil and small stones are thrown all around. Therefore, operator must wear protective cloths particularly mask, eye protector, shoe etc. Also, no other person/children should be allowed nearby.

9. **Advantage/Benefits/Utility of the technology:** It is suitable for cleaning of field before zero till sowing. Since, the developed machine is self-propelled and light in weight, it is highly suitable for small fields like terrace cultivation.

10. **Economics of the technology/ Benefit: Cost Ratio:** The cost of the machine is about Rs 25,000 (in year 2017). The operating cost is about Rs 1000 ha^{-1}. In case of manual cleaning, it may require about 80 hha^{-1} (about Rs 3000 ha^{-1}).

11. **Technology developed under the project:**

    ICAR sponsored project on "Development of equipment and technology to mechanize conservation agriculture (CA) on terraces under rainfed hill farming condition of NEH Region".

12. **Investigator(s)/inventor(s):**S. N. Yadav, S. R. Yadav and A. B. Sherpa**:** Email:snyadavbpl@yahoo.com; Mobile: 9933469544.

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TECHNOLOGY:
NECTAR-FM-101

1. **Name of the technology:** Ginger-turmeric washer
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Manipur
3. **Year of adoption/development:** 2017
4. **Description of technology with salient features:**

- The present invention is directed to the development of low-cost turmeric/ginger rhizome washing technology.
- The ginger/turmeric rhizome washer cum peeler (**Fig. 1 & 2**) mainly consists of a perforated rotary washing drum made of stainless steel having of 617 mm length and 500 mm diameter and 1.0 mm thickness mounted between two bearings through a long MS rod of 80 mm diameter supported on the MS angle iron frame.
- The perforated washing drum, encased in a stationery plastic cylinder, rotates in a horizontal axis where rhizomes are loaded in batch.
- The wall of the revolving drum is made perforated with 10 mm diameters hole having rough surface (protrusions) in the inner surface.
- The rubbing action of ginger over the rough inner surface removes the dirt and scale off the rhizomes.
- The rhizomes are loaded into the perforated drum by opening a door which can be opened and closed tightly with help of clamps during operation. (**Fig. 3**)
- The fresh water is put into machine upto half depth of the drum and after washing the rhizomes, the dirty water and soil can be drained out through drain pipe and valve which is provided below the plastic drum.
- The revolving drum is mounted on a long shaft of 30 mm diameter with nuts and bolts. The shaft is further is fixed on the main angle iron frame with the help of ball bearing on both sides. Loading and unloading of the rhizomes into the drum is done manually.
- Fresh water of about 8-10 l is poured into the plastic drum before starting the operation so that the rhizomes are submerged in the water and then rotated.
- The rotational speed of the drum at 100 rpm and 10 minutes duration is found to work satisfactorily in removing the adhering dirt, stains, other foreign materials or caked dirt on the rhizome or between segments of the rhizome.
- About 100-120 kg of rhizomes (**Fig. 4**) can be washed and peeled simultaneously in one hour in the machine.
- The technology developed will serve as a strong platform for translating scientific information to industries, academia and farmers for progressing research on small to medium scale level of ginger/turmeric processing.

5. **Specifications and other details:**

- Overall dimension : 900 x 800 x 1200 mm
- Weight : 200 g
- Prime mover : Manual
- Output capacity : 150 kg h^{-1}
- Unit cost (per machine) : Rs. 25,000
- Efficiency : Washing efficiency 91%
- Unit cost operation : Rs. 2.5100 kg^{-1} (washing)

6. **Critical inputs/ equipment/ items/ parts required:**

- Raw material : Turmeric rhizomes or Ginger rhizomes

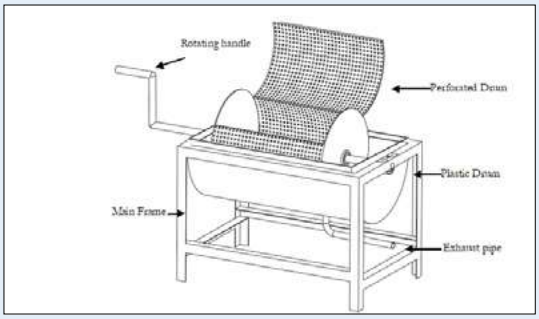

Fig. 1 Schematic diagram of Ginger-Turmeric Washer

Fig. 2 Ginger-Turmeric Washer

Fig. 3 Washed turmeric inside the Ginger washer cum peeler

Fig. 4 Washed and peeled ginger by the Ginger washer cum peeler

- Machinery: Ginger-Turmeric Washer
- Man power : 1 No.

6. Observations to be recorded:

- Rotational speed of the washing drum
- Percentage of washing and peeling
- Loading and unloading speed of the rhizomes

7. Target users/stakeholders: MTTCs/KVKs/Farmers/Agri-Entrepreneurs/Companies

8. Precaution(s) with the technology: The loading and unloading is manually done. The capacity of washing and peeling of rhizome depends on loading and unloading speed. Water level in the drum should not exceed half of the drum capacity. The used dirty water must be replaced for thorough cleaning of the washed rhizomes.

9. Advantage/Benefits/Utility of the technology: The machine reduces the drudgery involved in washing and peeling of turmeric /ginger rhizomes. During thorough washing operation, slight scaling/peeling of the rhizomes also takes place thereby saving about 50% time compared to the conventional method. It could be easily fabricated in local workshop and is cost effective.

10. Technology developed under the project: AICRP on PHET, ICAR-CIPHET, PAU, Ludhiana -141 004, India

11. Investigator(s)/inventor(s):

Ng. Joykumar Singh, P. K Sarangi and Th. Anand Singh: Email:joyngang@gmail.com, Mobile: 9612168301

12. Technology publication(s):

Singh, Ng. Joykumar, Sarangi, P. K., Singh, Th. Anand and Singh, Y. Jekendra (2015). Development and performance evaluation of ginger washer cum peeler for small farmers of NEH Region of India.*CAU Research Newsletter*,**6**(2): 8-9.

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TECHNOLOGY:
NECTAR-FM-102

1. **Name of the technology:** Pineapple peeler-corer-cum slicer
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Imphal**,** Manipur
3. **Year of adoption/development:** 2018
4. **Description of technology with salient features:**

The device consists of a stainless-steel central shaft to which slicing plate is attached in a spiral form. A stainless-steel pipe of 2.5 cm diameter and 25 cm length is used for fabrication of the pineapple peeler-cum-slicer. One end of the pipe is serrated for ease of penetration into the core of the fruit. A stainless-steel plate is attached to the pipe in a helical manner. Three sizes of helical cutting plate of 7 cm, 8 cm and 9 cm are fabricated to suit different sizes of pineapple. The open ends of the ring are sharpened and have a gap of 1.5 cm between them forming a groove for cutting the pineapple rings. The peeler-cum-slicer is pressed against the pineapple and twisted to cut the peel by side plate. The pineapple core is cut at the pipe end and inserted inside the pipe as the peeler is rotated forward and finally removed from the pipe. (**Fig. 1 & 2**) respectively show the Pine apple coring – slicing operation and the tool itself while (**Fig. 3**) shows the cut pine apple rings.

Specification and other details:

- Overall dimensions : 200 x 70 x70 mm
- Weight : 400 g
- Prime mover : Manual
- Output capacity : 30 fruits h^{-1}
- Unit cost of operation : Rs. 1 $pineapple^{-1}$
- Efficiency : 94.5% (peeling and slicing)

Fig. 1 Pineapple Peeling-coring-slicing operation

Fig. 2 Peeling-Coring-Slicing Tool

Fig. 3 Cut Pineapple Ring

5. **Critical inputs/equipment/items/ parts required:**

a) Raw material: Pineapple fruits

b) Machinery/ tool

c) Man power : 1 No.

6. **Observations to be recorded:**

- Pressure to be applied while pressing the cutting tool onto the pineapple.

- Ring size of the sliced pineapple
- Thickness of the pineapple ring
- Smoothness of the ring edge

7. **Target users/stakeholders:** MTTCs/KVKs/Farmers/Agri-Entrepreneurs/Companies

8. **Precaution(s) with the technology:**

   The pineapple fruits must be sorted first depending upon the sizes; viz. small, medium and large size, then suitable size of cutting blade must be used to reduce the losses of pineapple flesh which otherwise would go waste along with the peel. Overripe pineapple fruits are difficult to maintain the perfect shape of ring/ slice and thus find difficulty using the cutting tool.

9. **Advantage/Benefits/Utility of the technology:**

The tool reduces the drudgery in peeling and slicing of pineapple. The tool can perform multiple operations simultaneously i.e. peeling, coring and slicing of pineapple thereby saving the unit operation time by more than double folds.

10. **Unit cost (per tool):** Rs. 300

11. **Technology developed under the project: ICAR**-AICRP on PHET, ICAR-CIPHET, PAU, Ludhiana -141 004, India

12. **Investigator(s)/ inventor(s):**

    Ng. Joykumar Singh, P K Sarangi and Th. Anand Singh: Email:joyngang@gmail.com; Mobile: 9612168301.

13. **Technology publication:**

    CAU *Research Newsletter*, **8**(1): 12-13

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TECHNOLOGY:
NECTAR-FM-103

1. **Name of the technology:** Pineapple harvester
2. **Source of the technology:** COA (CAU, Imphal), Iriosemba, Imphal, Manipur
3. **Year of adoption/development:** 2018
4. **Description of technology with salient features:**

- The present technology is a small hand held motorized machine fabricated to harvest the pineapples fruits from the plants. The pineapple harvesting machine comprises of a serrated sharp cutting blade of 125 mm diameter and fruit holding clamps fixed on light weight steel pipe of 1500 mm length (**Fig. 1**)
- A one HP motor carried at the back of the operator transmits the rotational power to the cutting blade provided at the other end of the pipe. The speed of the blade is controlled by an accelerator button provided near to the handle.
- The rotating cutting blade cuts the stalk below the fruit and is lifted from the plant by holding the fruit with help of aluminum clamps provided in proximity the blade. In this way the operator does not suffer from the thorny leaves and spiky skin fruits, thereby reducing his drudgery. The total weight of the machine is only 9 kg.
- The cutting blade can be sharpened or replaced when damaged. The machine is capable of harvesting 250-280 pineapple fruits in one hour which is almost 50-60% higher capacity as compared to the conventional method of harvesting. The machine also eliminates other drawbacks, in addition of reducing drudgery, such as energy and time wastage of the operator. The **Fig. 2 & 3** shows the machine in operation.
- The technology developed serves as a strong platform for translating scientific information to industries, academia and progressive farmers for harnessing research on pineapple processing.

Specification and other details:

- Overall dimension : 1500 (L) mm x 130 (B) mm
- Weight : 9 kg
- Prime mover : Petrol engine
- Power (hp) : 1.0
- RPM of the rotary blade – power transmission from the petrol engine.
- Output capacity : Field capacity 250-280 fruits h^{-1}
- Unit cost of operation : Rs. 1.5 pineapple $fruit^{-1}$
- Efficiency : 70.44% (harvested fruits)

Fig.1 Pineapple harvester showing all the parts

Fig. 2 & 3 Pineapple harvester in operation

Critical inputs/equipment/items/parts required:

- Raw material : Pineapple
- Machinery : Pineapple harvester
- Man power : 1 No. (single operator)

6. **Observation to be recorded:**

- RPM of the rotary blade – power transmission from the petrol engine.
- Cutting of pineapple fruit at stalk without cutting much leaves/suckers
- Holding clamp holds the plucked fruits after cutting at stalk.

7. **Target users/ stakeholders:** MTTCs/ KVKs/Farmers/ Agripreneurs

8. **Precaution(s) with the technology:** The size of cutting blade of the machine must not be too big to avoid unnecessary cutting of tender leaves of the pineapple plant during harvesting operation. The serrated blade of the machine must be sharpened and be rotated at high speed as it has to cut the fibrous and tough stalk. After cutting the stalk of fruit, the holder must hold the fruit tightly simultaneously and lift the cut fruits from the plant.

9. **Advantage/Benefits/Utility of the technology:** The machine can harvest the pineapple fruit without going very close to the plant which is thorny, thereby reducing the drudgery to the operator. The conventional method is not only time consuming and laborious but also causes backache as harvester usually bends his back while cutting the fruits from plant. Fruit damage during harvesting operation can be avoided by using the machine.

10. **Economics of the technology/Unit cost/Benefit: Cost Ratio:** Rs. 10,000

11. **Technology developed under the project:** AICRP on PHET, ICAR-CIPHET, PAU, Ludhiana -141 004, India

12. **Investigator(s)/inventor(s):** Ng. Joykumar Singh, P. K. Sarangi and Th. Anand Singh; Email: joyngang@gmail.com, Mobile: 9612168301.

13. **Technology publication(s):**

Singh, Ng. Joykumar (2016). Pineapple harvesting technology in hilly slope areas of NEH. *CAU Research Newsletter*, **7**(1): 4-5. ISSN: 2319-3042.

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TECHNOLOGY:
NECTAR-FM-104

1. **Name of the technology/new breed:** Pony driven cart for agricultural farm
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Manipur
3. **Year of adoption/development:** 2019
4. **Description of technology with salient features:**

a) Background concept of the developed technology

Manipuri Pony breed has been well known as Polo Pony. The main background concept of this technology is to conserve the seriously endangered Manipuri Pony breed by utilizing those animals of the breed which are not suitable for Polo game in other suitable activities. Being an agricultural state, one relevant option is to utilize the animals in farm activities of the state. However, in many places where the horses and ponies are utilized, the various farm activities carried out without any consideration to the load bearing capacity, work duration and drudgery these animals face, thereby compromising ethics and welfare issues of these animals. In view of this, avoidance of overloading the animal while utilizing them, is the main objective of this technology. Hence, a "Pony Cart" has been developed with the dual objective of taming the ponies and also to harness them to carry loads as per the load carrying capacity of the animal. The latter was tested from the studies of various physiological and biochemical parameters of the ponies, which are good indicators of stress/metabolic crisis.

b) Parameters studied

Physiological parameters	Temperature, heart rate and respiration rate
Biochemical parameter	ALP, ALT, AST, Lactate Dehydrogenase, Glucose, total protein, sodium, potassium, chloride

c) Design of the carrier

The cart is designed to suit the Manipuri Pony breed for carrying agricultural commodities in and around the farm. The cart is provided with two pneumatic tire wheels and for easier movement of the carrier, the wheel is supported with elliptical springs, which help in the absorption of shock. The wooden floor fitted on a rigid frame is made of mild G.I pipe. All the sides except the rear side will have fixed vertical wooden walls of 18 inches high for supporting the materials to be carried as well as to limit from overloading the cart with excess weight. The cart is fitted to the animal body with a pair of beams made out of mild steel pipes. The beam has leverage to oscillate vertically so that vertical movement of the animal will not affect the cart. Besides, the load on the cart will not be carried by the animal for vertical movement. The **Fig. 1 - 4** shows various views of the developed pony driven cart.

d) Economic traits of Manipuri pony

- Adaptable in local climate and scarce feeding situation
- Highly resistant to various local diseases
- Highly alert, possess tremendous power of endurance and surefootedness and as such in high demand for polo game.

e) Body requirements

Sl. No	Parameters	Requirements
1.	Body characteristics	• Neck, shoulder and hindquarter should be muscular, showing strength. Knee and hock joint must be well developed for its size. Hoof should be tough and compact.
2.	Body measurement	• Medium to large size. Height at withers must be around 125-136 cm. • Chest girth must be around 135-155 cm
3.	Appearance	• Sturdy
4.	Nature	• Cool temperament

Fig. 1 Cart with the Pony

Fig. 2 Pony Driven Cart

Fig. 3 Side of Pony Driven Cart

Fig. 4 Pony Driven Cart on the road

f) Technical specification of the Pony Cart Convert these dimensions in cm/m

- Length of wooden floor: 80 inches
- Length of wooden part of carrier box: 54.5 inches
- Height of carrier wooden box area: 18 inches
- Total height from floor: 43 inches
- Length of arm up to angular area: 50 inches
- Length of curve of the arm: 25 inches
- Length of carrier space: 25 inches
- Front height from floor to platform: 22 inches
- Height of left, right and rear side of carrier: 22 inches
- Whole breadth from tire to tire: 53 inches
- Weight of the carrier: Ranges from 200 to 240 kg.

g) Area of utility : Valley districts of Manipur state.

h) Sector of utility

- Small farm sector in and around the farm.

- Can be used by the farm family or hire on rent basis to other farmers for carrying agricultural, horticultural and animal husbandry products or inputs such as vegetables, fruits, seeds, paddy, fertilizer, straw, green fodder, manure, animal feed etc.
- For family use, it will reduce the transportation cost and labour charge as well as drudgery to the family members and staff.

i) Recommended practices/protocol for use of the draft or pulling pony

- As far as possible, load must be within 350 kg.
- Give warm up light exercise to the pony through walking for about 10-15 minutes before putting the cart. Such exercise can avoid work related injury to the muscle.
- Feeding should be done at least 2 h before pulling load.
- Give sufficient rest if there is sign of fatigue, respiratory distress etc.
- Provide water whenever required, particularly in case of excessive sweating.
- As far as possible, avoid using ponies during excessive heat period.
- Tie them at a comfortable windy area after every journey, such as shade under the tree or nearby.

j) Work-rest protocol of the pulling pony

- Light Pulling - 5 - 10 minutes
- More pulling - 20-25 minutes
- Light pulling - 5- 10 minutes
- Stop/rest - 15-20 minutes

k) Shelter management

Provide 12 x 12 feet^2 m^{-2} in place of square feet floor area with proper drainage facilities. Water trough and feed trough may be provided separately at two ends of the corner. Roof must be at least 12-14 feet high.

l) Feeding management

- Feed the pony at least 25-30 kg of green fodder along with 3-5 kg of dry hay or straw per day.
- Concentrate or available feeds such as oat, gram, maize, bran may be given @ 2-3 kg per day.
- Water must be available *adlib.*
- Provide mineral mixture as per requirement.

m) Disease management

- Check temperature of the pony daily in the morning, so that any changes may be taken care of at the earliest.
- Both allopathic and herbal treatments can be used.
- If infectious disease is suspected, take the help and services of veterinarian promptly.

n) Disadvantages

- Training of ponies

o) Unit cost

- Cost of pony (not utilized for polo) ranges from Rs. 25,000 to Rs. 40,000 (approx.) and cart ranges from Rs. 30,000 to Rs. 40,000. Hence, total unit cost is approximately Rs. 55,000 to 80,000 at the beginning.

5. Target users/stakeholders: Farmers/ Interested people

6. Advantage/ Benefits/ Utility of the technology:

- Expenditure on fossil fuel is saved.
- To some extent, environment will be saved for future generation due to less carbon emission.
- Underutilized pony energy will be utilized

for agricultural development, which is the one of the primary means of income and source of livelihood for the people of this state.

- In social aspect, the drudgery level of the local farmers will be reduced.
- There is an opportunity for the endangered pony to be well fed and cared by the pony owners through earning from hiring service and thus paves a hope to save the pony from extinction.

7. Economics of the technology/new breed:

For self-farm use

- Expenditure required for transport of farm commodities in and around the farm is saved.

Income from hiring service

- A cart journey with a capacity of 350 kg load h^{-1} charged around Rs. 400. As such, in a minimum of 4 hours work in a day, the owner can earn Rs. 1600 day^{-1}. In a year, the owner can get 90 days of work, particularly in sowing and harvesting season. As such, his income will be around Rs.1,44,000 $year^{-1}$.

The maintenance cost of the pony will be as follows:

- Green fodder per day -25 kg @ R.2.50 kg^{-1} = Rs. 62.50
- Dry fodder/straw per day- 5kg @: Rs. 3.00 kg^{-1} = Rs. 15.00
- Concentrate/bran/maize etc. day- 2.5 kg^{-1} @ Rs. 28 kg^{-1}: Rs 70
- Work days: 90 days: Rs.147.50 day^{-1} $pony^{-1}$ x 90 days = Rs. 13, 275
- No work days: 270 days: Green and dry fodder only: Rs.77.50 x 270 days: Rs. 20,925
- Grand total: Rs. 13,275 + Rs. 20,925= Rs. 34,200
- **Profit per year**: Income- maintenance cost: Rs. 1,44,000 - Rs. 34,200 = Rs. 1,09,800
- **Profit per month:** Rs. 9,150

8. Technology developed under the project:

"Generation of pony-based animal energy for utilization in agricultural development of Manipur state" funded by Department of Science & Technology, Ministry of Science & Technology, Government of India.

9. Investigator(s)/inventor(s):

Principal Investigator: Th. Ranadhir Singh and P.T. Sharma: Email: rdthiyam@yahoo.co.in

10. Technology publication(s):

Singh, Th. Ranadhir (2018). Brochure on Manipuri Pony Cart. Published under the project "Generation of Pony Based Animal Energy for Utilization in Agricultural Development of Manipur state" funded by Department of Science & Technology, Ministry of Science & Technology, Government of India.

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TECHNOLOGY:
NECTAR-FM-105

1. **Name of the technology:** Makhana harvester
2. **Source of the technology:** COA (CAU, Imphal), Iroisemba, Imphal**,** Manipur
3. **Year of adoption/development:** 2019
4. **Description of technology with salient features:**

- A manually operated *Makhana* (*Euryale ferox* Salisb.) harvesting technology under the water surface consists of a high-resolution camera fixed near to the cutting blade and telescopic aluminum pipe of variable length
- The makhana harvester is provided with a water proof borescope camera fixed close to the cutting blade. The android camera having external diameter of 5.5-7.0 mm built-in with 6 adjustable white LED lights and photo control switch having a focal distance of 4 cm to infinite and water proof level of IP67, resolution of HD: 640*480 is connected to android mobile through OTG cable of 1500 mm long (**Fig. 1**).
- The camera takes the image of the fruits or any objects inside the water (clear to semi muddy water condition) and is displayed on the display screen of android mobile. Hence, the operator can easily locate the object (makhana fruits) inside the water up to 0.3 to 0.5 m depth and cut the fruit stalk and then lift out of water. The **Fig. 2** shows the Makhana harvester in operation
- In this way the operator is saved from the thorny leaves and spiky skin fruits, thereby reducing his drudgery.
- The gadget is capable of harvesting 150-200 makhana fruits in one hour which is almost 50-60% higher capacity as compared to the conventional method of harvesting. The operator need not go down into the water for search of makhana. The technology not only displays advanced optical technological implementation for harvesting of *Makhanas,* but also provides advanced manual harvesting tool for benefit to low income people.
- The technology is believed to serve as a strong platform for translating scientific information to industries, academia and progressive farmers for advancing research on makhana processing.

Specification and other details:

- Overall dimension : 1500 (L) mm
- Weight : 2.0 kg
- Prime mover : Manually operated
- Output capacity : Field capacity 150-200 fruits h^{-1}
- Unit cost of operation : Rs. 1 kg^{-1} Makhana fruit
- Efficiency : 85% (harvested fruits)

5. **Critical inputs/equipment/items/ partsrequired:**

- Raw material : Makhana
- Machinery
- Man power : 1 No. (single operator)

6. **Observation to be recorded:**

- Depth of water upto which the camera can detect the object inside the water.

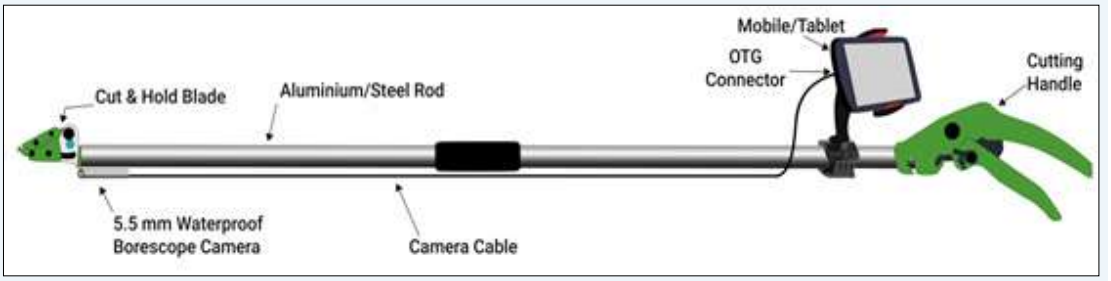

Fig. 1 Schematic diagram of Makhana harvester

- Angle of curvature of the cutting blade and sharpness of blade
- Holding of plucked fruits after cutting and lifting from water.

7. **Target users/stakeholders :** MTTCs/ KVKs/ Farmers/ Agri-Entrepreneurs/ Companies

8. **Precaution(s) with the technology:** Proper detection of the makhana inside the water and holding the fruits at stalk must be taken care during harvesting. The cutting blade must be sharpened often and holding pad must be cleaned to prevent from chocking/sticking of the materials on the surface.

9. **Advantage/Benefits/Utility of the technology:** The operator is saved from his direct contact with thorny leaves and spiky skin fruits, thereby reducing his drudgery. The gadget is capable of harvesting 150-200 makhana fruits in one hour which is almost 50-60% higher capacity as compared to the conventional method of harvesting. The gadget also eliminates other drawbacks, in addition to reduction of drudgery, such as wastage of energy and time of the operator. The technology will serve as a strong platform for translating scientific information to industries, academia and progressing farmers for progressing research on makhana processing.

Fig. 2 Makhana harvester in operation

10. **Economics of the technology/unit cost per machine:** Rs. 5,000

11. **Technology developed under the project:** AICRP on PHET, ICAR-CIPHET, PAU, Ludhiana -141 004, India

12. **Investigator(s)/inventor(s):**

    Ng. Joykumar Singh, P K Sarangi and Th. Anand Singh Email:joyngang@gmail.com, Mobile: 9612168301.

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Chapter - 7

POST-HARVEST TECHNOLOGY (PHT) 25 technologies

TECHNOLOGY:
NECTAR-PHT-106

1. **Name of the technology:** Extruded snack from fish (Fish *Kurkure*)
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of adoption/development:** 2011
4. **Description of technology with salient features:**

Extruded snack like products rich in nutrients of fish is made with corn powder, rice flour and fish mince. Mince from any low-cost fish can be used. Fish *kurkure* (**Fig. 1**) is a crispy ready to eat snack with superior nutritional quality as it is rich in fish protein.

Procedure:

- Mix all the ingredients with addition of water till a homogenous mixture is obtained.
- The ingredient mix is allowed to mature for 3-4 h at room temperature
- The mixture is then fed to twin screw extruder set with previously optimized operational parameters for extrusion cooking.
- Final product comes out through 2.5-3.5 mm diameter opening which is cut into required length
- The extrusion product is dried in mechanical dryer (50ºC temp.)
- Spicing with flavored powder, chat *masala*, garam *masala*, red chilli powder and salt after frying in oil for 2-3 sec.
- Pack the product in nitrogen flushed aluminum foil package to required amount (**Fig. 2**).

Fig. 1 Fish *Kurkure*

Fig. 2 Packed Fish *Kurkure*

5. **Critical inputs/ equipments/ ingredients/ raw materials etc. required:**

- Equipment: Twin screw extruder, Fish dryer, meat mincer , heavy duty grinder, impulse sealing machine with provision for nitrogen flushing
- Other inputs: Any fish, packaging materials

6. **Observations to be recorded:**

- Organoleptic quality of the product
- Textural quality
- Shelf-life at room temperature

7. **Target users/stakeholders:**

   Multi Technology Testing Centers: MTTCs/KVKs/SHGs/NGOs/Entrepreneurs/Farmers

8. **Precaution(s) with the technology:** Good texture of the extruded product with expansion ration 1:4 and above is required for consumers' acceptability. Packing without nitrogen may cause oxidation of fats resulting rancid smell and spoilage of the product.

9. **Advantage/Benefits/Utility of the technology:** This is a crispy snack but more nutritious than the similar products available in the market which are made with cereals only.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 1.21

11. **Technology developed under the project:**

    Developed under research initiative of the College of Fisheries, Lembucherra funded by CAU (Imphal)

12. **Investigators/ inventors:** R. K. Majumdar: Email: drrkmcof@gmail.com; Mobile: 9862441057

13. **Technology publication(s):**

Singh, R. K. Ratankumar, Majumdar, R. K. and Venkateshwarlu, G. (2014). Effect of process conditions on physico-chemical and sensory properties of fish-cereal based extruded snack like products. *Journal of Food Processing and Preservation*, **38**(1): 68-82. DOI: 10.1111/j.1745-4549.2012.00746.x.

Singh, R. K. Ratankumar, Majumdar, R. K. and Venkateshwarlu, G. (2014). Optimum extrusion-cooking conditions for improving physical properties of fish-cereal based snacks by response surface methodology. *Journal of Food Science and Technology*, **51**(9): 1827-1836.

Majumdar, R. K. and Singh, R. K. Ratankumar (2012). The effect of extrusion conditions on the physicochemical properties and sensory characteristics of fish-based snack like products. *Journal of Food Processing and Preservation*, **38**(3): 864-879. DOI: 10.1111/jfpp.12041.

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TECHNOLOGY:
NECTAR-PHT-107

1. **Name of the technology:** Packing technology for orchid cut flowers
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2011
4. **Description of technology with salient features:**

Shrink packaging is the most effective and convenient method of handling of high value flowers for domestic market. In this technology, fresh and undamaged *Cymbidium* orchid flowers are selected through sorting. The stems of flowers are trimmed to suitable length. The flowers are then put in individual vials containing water. These flowers along with water vials are then inserted into cardboard cartons or bamboo container. The cardboard cartons or bamboo container along with flower is packed in shrink film and sealed using hand sealer. The sealed container is passed through shrink wrapping machine maintained at a temperature of 115°-120**°C.**Due to this temperature, the shrink film is tightly wrapped around the cardboard carton or bamboo container. The shrink packed orchid flowers have shelf life of 21 – 30 days in ambient conditions of metro cities. The shrink packed flowers can be used as decorative items, gifts etc. The **Fig. 1** shows the flow process chart of shrink packaging of orchid flowers while **Fig. 2-4** show the photographs of packaging technology.

5. **Critical inputs required:**

   Orchids, Cartons, Bamboo container, vials, Shrink packaging film, Hand sealer, and Shrink wrapping machine.

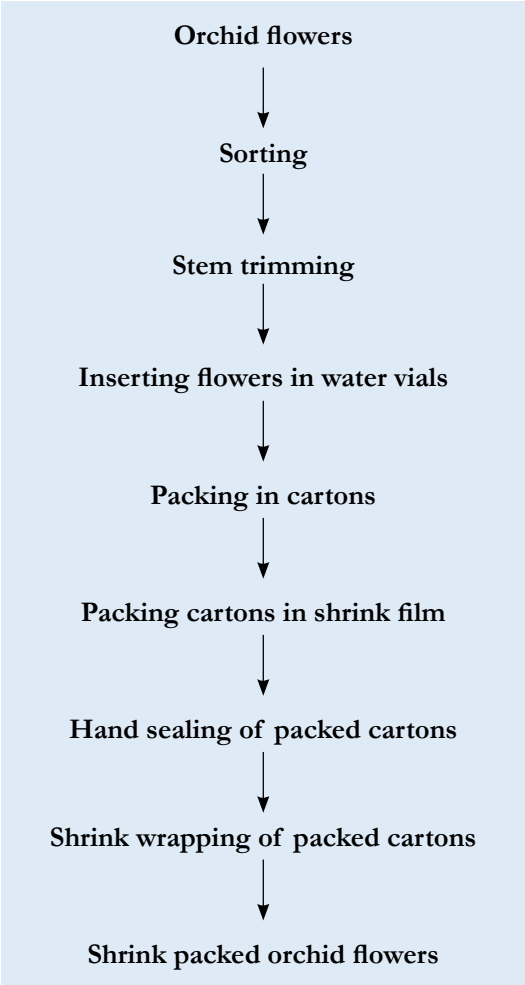

Fig. 1 Process flowchart for shrink packed orchids

6. **Observations to be recorded:**

- Length of cut flowers, shrink packaging temperature

7. **Target users/stakeholders :** MTTC/ KVKs/ Line department

Fig. 2. Bamboo container/ cardboard carton

Fig. 3. Shrink wrapping machine

Fig. 4. Shrink packaged orchid flowers

8. **Precaution(s) with the technology:** The packaging film selected should be shrink packaging film.

9. **Advantage/Benefits/Utility of the technology:** This technology iseco-friendly. There is no wastage produced through this technology. The technology imparts value addition to fresh orchid flowers. Further, the technology may be successfully used for shrink wrapping of other flowers like *Androbium*, roses etc.

10. **Economics of the technology/ Benefit: Cost Ratio:**1: 1.11

11. **Technology developed under the project:** Packaging study of Sikkim orchids (*Cymbidium* sp.) (B. Tech. Project)

12. **Investigator(s)/inventor(s):**

    A. I. Singh (Late) and Sujata Jena: E mail: sujata_jena@hotmail.com, Mobile: 9933467570

13. **Technology publication(s):**

    Bordoloi, R., Deka, B. C., Singha, A. K., Kumar Bagish, Jat, P. C, Sarma, C. K. and Borgohain, R. (eds.) (2017). Technology Inventory of North East India: Pub: ICAR-ATARI Zone VII, Umiam, Meghalya. pp. 312: Chapter 02: Technology No. 35: Value addition of high value cut flowers. p. 71.

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TECHNOLOGY:
NECTAR-PHT-108

1. **Name of the technology:** Blended RTS beverages using passion fruit, Sikkim mandarin and ginger
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2011
4. **Description of technology with salient features:**

Blended Ready-to-Serve (RTS) beverage is a healthy nutritional drink produced through mixture of fruits viz., passion fruit, Sikkim mandarin and ginger juices. It contains at least 10% pulp or fruit juice and 10-15% TSS with 0.3% titrable acidity. The procedure (Fig.1) consists of first selecting good quality fruits of choice (mandarin orange, passion fruit or fresh ginger) and washed. Ginger is sliced into small pieces. Sikkim mandarin and passion fruits are cut into halves. Juice is extracted from cut Sikkim mandarin, passion fruits and ginger slices using juice extractor. Passion fruit juice and Sikkim mandarin juices are mixed with ginger juice at a ratio of 4:1 and 2:1 respectively. Sugar syrup is prepared by mixing of sugar and water.

The mixed juice is then added to sugar syrup and mixed properly. Potassium metabisulphite (KMS) is added @ 0.1% as a preservative in these beverages. The empty glass bottles and crown caps are pre-sterilized in hot boiling water at 100°C for 15 minutes before filling. The blended RTS beverage is filled in pre-sterilized glass bottles, crown corked and pasteurized at 100°C using boiling water for 15 minutes. The filled bottles are then cooled before storage. This passion fruit-ginger RTS and Sikkim mandarin-ginger RTS beverage (**Fig. 2 & 3**) can be stored for 3 months under normal storage temperature of 25°C.

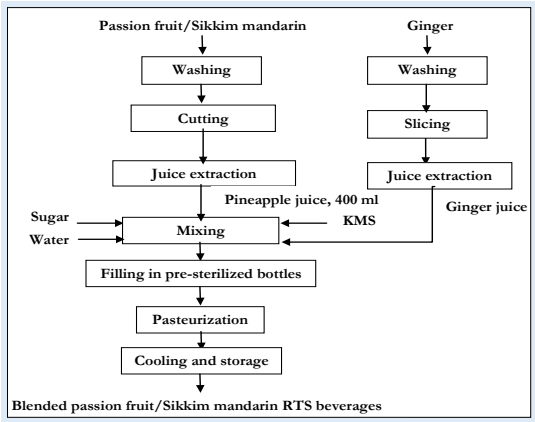

Fig. 1 Process flowchart for Blended passion fruit/ Sikkim mandarin RTS beverages
RTS beverage

Fig. 2 Passion fruit-ginger RTS

Fig. 3 Sikkim mandarin-ginger RTS

Table 1 Composition of the blended RTS beverages

Ingredients	Passion fruit-ginger RTS	Sikkim Mandarin-ginger RTS
Fruit juice	8 %	7%
Ginger juice	2%	3.5%
Sugar	12.5%	10.0 %
Water	77.5%	79.5 %
KMS	0.1%	0.1%

5. **Critical inputs required:**

   Passion fruit, Sikkim mandarin, ginger, sugar, additives, water, glass bottles, washer, refractometer, juice extractor, mixing tanks, crown corking machine, gas burner and weighing balance.

6. **Observations to be recorded:**

- Total soluble solids of juice and RTS beverages
- Acidity of juice and RTS beverages
- Pasteurization temperature and time

7. **Target users/stakeholders:** MTTC/ KVKs/ Line department

8. **Precaution(s) with the technology:**

- Properly ripe fruits should be selected for more juice recovery and sweetness.
- Bottles should be properly pasteurized both before and after filling to extend shelf life.

9. **Advantage/Benefits/Utility of the technology:** Passion fruits, Sikkim mandarin and ginger are the unique and important horticultural crops of North East India. Passion fruit juice is a natural antioxidant and a good source of vitamin-c and carotenoid pigments. Due to its exotic flavor, it could be blended with several fruit juices to make acceptable beverages. Blending technology thus offers scope of value addition to these horticultural crops of NEH region besides offering other advantages such as time saving and efforts in post-harvest management of marketing of individual raw products, and development of different types of ready to serve (RTS) beverages with improved taste, aroma, nutrition and higher shelf life.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1.5:1

11. **Technology developed under the project:** IRP on "Application of blending/ Mixture Technology for development of different types of beverages using locally produced Horticultural crops like Sikkim Mandarin, Passion Fruit, Ginger etc." funded by CAU, Imphal.

12. **Investigator(s)/inventor(s):**

    P. K. Srivastava and Sujata Jena, E mail:sujata_jena@hotmail.com Mobile: 9933467570

13. **Technology publication(s):**

IRP report submitted to CAU, Imphal.

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TECHNOLOGY:
NECTAR-FPT-109

1. **Name of the technology:** Ready -To-Serve (RTS) pineapple juice- a value added product
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2013
4. **Description of technology with salient features:**

Ready-to-serve (RTS) pineapple juice is a value-added pineapple product intended for consumption without dilution and prepared from unfermented pure fruit juices. It contains at least 10% pulp or fruit juice and 10-15% TSS with 0.3% titrable acidity. For the making of acceptable quality pineapple RTS beverages, first ripe pineapple fruits are selected, washed, peeled and cored. The fruit is then cut into small pieces and juice is extracted using fruit juice extractor. Sugar syrup is prepared by mixing 1.125 kg sugar and 7.75 kg water 1 kg^{-1} of pineapple juice. This prepared syrup is then mixed with the extracted pineapple juice. Potassium Metabisulphite (KMS) is added as a preservative to the prepared RTS beverage @ 0.1%. The prepared RTS beverage is then filled into the pre-sterilized glass bottles. The empty glass bottles and crown caps need to be pre-sterilized in hot boiling water at 100°C for 15 minutes before filling. The filled bottles are then sealed air tight using crown caps by crown corking machine. The filled and sealed bottles are pasteurized in boiling water (100°C) for 15 minutes followed by cooling in ambient air. The **Fig. 1** shows the flow process chart of the technology while **Fig. 2** shows the developed RTS beverage. These beverages have a shelf life of 90 days in glass bottles under normal storage temperature of 25°C. Table 1 presents the composition of Pineapple RTS beverage.

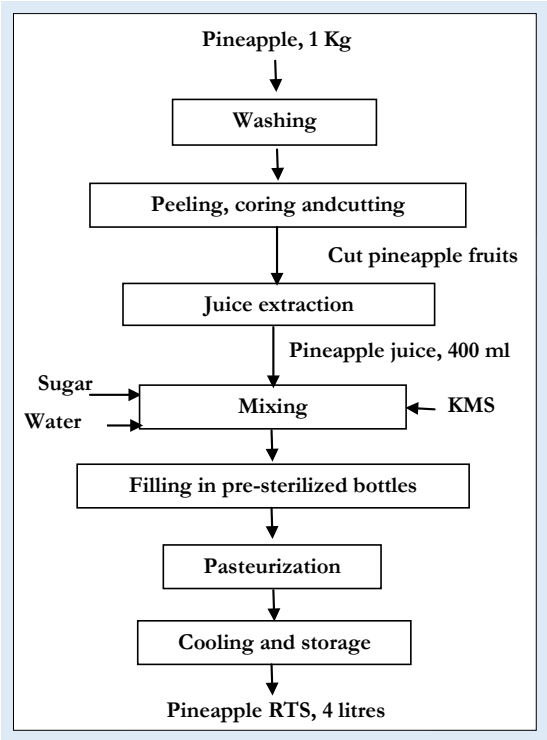

Fig. 1 Process flowchart for Pineapple RTS beverage

Fig. 2 Pineapple RTS beverage

Table 1 Composition of pineapple RTS

Ingredients	Pineapple-ginger RTS
Pineapple juice	10 %
Sugar	12.5%
Water	77.5%
KMS	0.1%
TSS	10-14° Bx

5. **Critical inputs required:**

   Pineapple, sugar, portable water, refractometer, additives, washer, cutter, corer, juice extractor, crown corking machine,mixing tanks, gas burnerand weighing balance.

6. **Observations to be recorded:**

- Total soluble solids content (TSS)of juice and RTS beverages
- Acidity of juice and RTS beverages
- Pasteurization temperature and time

7. **Target users/stakeholders :** MTTC/ KVKs/ Line department

8. **Precaution(s) with the technology:**

- Properly ripened fruits should be selected for higherjuice recovery and sweetness.
- Bottles should be properly pasteurized both before and after filling to extend shelf life.

9. **Advantage/Benefits/Utility of the technology:** The RTS beverage developed through this technology is free from any added colour or flavour. This simple technology offers a very good alternative for new entrepreneurs to get additional income through value addition.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1:1.94.

11. **Technology developed under the project:** NA

12. **Investigator(s)/inventor(s):**

    Sujata Jena: E mail: sujata_jena@hotmail.com,Mobile: 9933467570

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TECHNOLOGY:
NECTAR-PHT-110

1. **Name of the technology:** Retortable pouch processed ready-to-serve fish curry in northeast Indian style
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of adoption/development:** 2013
4. **Description of technology with salient features:**

Retort pouch technology is perhaps the most advanced technique in food packaging since the advent of the metal can. Fish/prawn curry in North-eastern style as well as curry of indigenous fermented fish products of northeast India can be processed in retortable pouch using over-pressure retort. Curry made from fresh fish, fermented fish, dry fish of any recipe is sterilized up to commercial sterility in 3-ply laminated retortable pouch using over-pressure retort. The time-temperature of sterilization is designed on the basis of organoleptic evaluation and sterilization value (F_0) is obtained using Thermal Validation and Sterilization Monitoring System. Shelf-life of the processed products has been found to vary from 6 months to one and half year at room temperature. Flow-chart of the technology is given below in **Fig. 1** while **Fig. 2** (**a-h**) shows the different stages of product preparation and final marketable products**.**

Raw material (freshwater fish)
↓
Washing (chilled & potable water)
↓
Descaling, beheading, gutting, steaking
↓
Washing of steaks (chilled water)
↓
Pre-processing of fish steaks
↓
Marinating with turmeric powder for 20 min
↓
Shallow frying of fish steaks for 10-12 sec in refined oil
↓
Preparation of gravy
↓
Filling of hot gravy to retort pouch
↓
Retorting
↓
Labelling and storage

Fig. 1 Flow-Chart: Thermal processing of freshwater fish in curry medium

5. **Critical inputs/ equipment/ ingredients/ raw materials etc. required:**

- Equipment: Over-pressure retort, impulse sealing machine, thermal process monitoring system.
- Other inputs: Fresh fish, fermented fish products, ingredients, ¾-ply flexible retortable pouch etc.

6. **Observations to be recorded:**

- Organoleptic quality of the product
- Sterilization value
- Commercial sterility
- Consumers' acceptance

7. **Target users/stakeholders:** MTTCs/ KVKs/SHGs/NGOs/Entrepreneurs/ Farmers

Fig. 2 (a to h) Different stages of product preparation and final marketable products

8. **Precaution(s) with the technology:** Under-sterilized product may carry spores of *Clostridium botulinum* and consumption of the product with botulinum toxin may be life threatening. So, test of commercial sterility is must before first time production.

9. **Advantage/Benefits/Utility of the technology:** This is a hi-value addition and diversification of product to satisfy the ever changing and diverse demands from the urban dwellers those who do not have time to spend in cooking. This may also serve as convenient product for the travelers and defense personnel.

10. **Economics of the technology/ Benefit: Cost Ratio:**1: 2.21

11. **Technology developed under the project:**

    Ministry of Food Processing Industries (MoFPI), GOI funded project entitled "Development of ready–to-serve fish products through flexible retort pouch technology for North East markets".

12. **Investigator(s)/inventor(s):** R. K. Majumdar: Email: drrkmcof@gmail.com; Mobile: 9862441057

13. Technology publication:

Majumdar, R. K., Dhar, B., Saha, A., Roy, D., Parhi, J. and Singh, A. S. (2016). Evaluation of textural quality as a parameter to optimize thermal process during retort pouch processing of bone-less Rohu balls in curry medium. *Journal of Food Processing and Preservation*, **41**(3) (Published on-line, DOI:10.1111/ jfpp.12925).

Majumdar, R. K., Dhar, B., Roy, D. and A., Roy (2015). Optimization of process conditions for Rohu fish in curry medium in retortable pouches using instrumental and sensory characteristics. *Journal of Food Science and Technology,* **52**(9): 5671-5680. (DOI:10.1007/s13197-014-1673-3).

Majumdar, R. K., Dhar, B., Roy, Dand Saha, S. (2015). Study of instrumental and sensory characteristics of Catla in curry medium during retort pouch processing to optimize F_0 value. *Journal of Food Processing and Preservation,* **39**(6): 1595-1604 (DOI:10.1111/ jfpp.12388).

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TECHNOLOGY:
NECTAR-PHT-111

1. **Name of the technology:** Smoked laminates from pangasius fish
2. **Source of the technology:** COF (CAU, Imphal), Lembucherra, Tripura
3. **Year of adoption/development:** 2014
4. **Description of technology with salient features:**

Smoked laminates from Pangasius fish can be developed as a diversified value-added product. The product is new in the Northeast India and there was a good response from the consumers. The details of the preparation procedure/method are described below in **Fig. 1 & 2**.

Fresh Pangasius fish

↓

Dressing into fillets

↓

Washing at a ratio of 1:4 (fish: water) in chilled water

↓

Brining for 20-30 min

↓

Air drying by hanging

↓

Pressing of fillets in between metal plates in screw press

↓

Drying in a mechanical dryer at 55-60° C and for 12 hours up to 30-35% moisture

↓

Smoking laminates in a smoked chamber till a smoky flavor and characteristic golden-brown color

↓

Final product is semidried- smoked laminate

↓

Cooling and packing in polythene pack with vacuum sealing

Proximate composition of freshly prepared

Fig. 1 Flow chart for preparation of smoked laminates

Fresh Pangas fish

Smoking of Pangas laminates

Vacuum packed Smoked laminates pangas

Fig. 2 Processes for preparation of smoked laminates

semi-dried and semi-dried smoked laminates of pangasius fish:

Product type	Moisture (%)	Dry matter (%)	Protein (%)	Lipid (%)	Ash/ mineral (%)
Smoked laminates	28.76±0.07	71.34±0.11	38.79±0.19	7.26±0.01	4.80±0.03

5. **Critical inputs equipments/ ingredients/ raw materials etc. required:**

- Pangasius fish, dryer, mechanical smoking kiln, screw press/laminating machine, impulse sealing machine with nitrogen flushing/vacuum sealing machine, packaging materials with good thickness

6. **Observations to be recorded:**

- Biochemical quality of the product
- Organoleptic quality of the product
- Textural quality
- Shelf-life at room temperature

7. **Target users/stakeholders:**

   MTTCs/KVKs/SHGs/NGOs/ Entrepreneurs/Individual farmers/Rural women

8. **Precaution(s) with the technology:** Need treatment with antifungal agent (at a low dose) before proper packaging after preparation to avoid fungal attack and take up of moisture by the products when stored under ambient condition. Moreover, products from fatty fish like pangas needs vacuum packaging to eliminate any chances of oxidation.

9. **Advantage/Benefits/Utility of the technology:** This product is advantageous than ordinary dry fish as fish is processed before smoking, prepared hygienically and easy to cook like other dry and fermented fish products.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1: 1.32

11. **Technology developed under the project:**

    CAU (Imphal) funded IRP entitled "Application of curing technology on *Pangasius* sp. with special emphasis on acceptability and economic feasibility".

12. **Investigator(s)/inventor(s):**

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TECHNOLOGY:
NECTAR-PHT-112

1. **Name of the technology:** Pre-processing technique for reducing cyanide levels in bamboo shoot
2. **Source of the technology:** CAE&PHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development:** 2014
4. **Description of technology with salient features:**

Bamboo shoots are found to contain high amount of natural plant toxin, the cyanogenic glycosides specifically taxiphyllin. These toxic substances, if not processed appropriately during food preparation, releases the toxic cyanide and when ingested in significant amount these toxins can be potentially harmful to human health thereby causing food poisoning. Various studies were performed to determine the best method for reducing maximum cyanide level in bamboo shoot. The following technique (**Fig. 1**) is found suitable for maximum cyanide reduction (raw/fresh: 600 ppm; boiling for 20 minutes: 60 ppm; pressure cooking for 15 minutes with 3% NaCl: 10 ppm):

Fresh Bamboo Shoot

↓

Remove the sheath

↓

Trim it to extract the edible portion

↓

Discard the tip of the shoot (as the tip portion is found to contain highest level of cyanide in the bamboo shoot)

↓

Cut the edible portion

↓

Soak overnight in water

↓

Boil for 20 minutes (or pressure cook for 15 min) with 3% NaCl

↓

Rinse the shoots with water

↓

Ready for further food preparation/ consumption (85-90% reduction in cyanide level of the bamboo shoot)

Fig. 1 Process chart for reducing cyanide levels in bamboo shoot

Fig. 2 Bamboo Shoot growing in its natural habitat

Fig. 3 Edible bamboo shoot with its sheath removed

Fig. 4 Sliced bamboo shoots

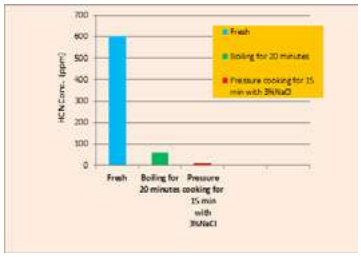

Fig. 5 Cyanogen content in Bamboo Shoot for different pre-processing method

(**Fig. 2-4**) show respectively the bamboo shoot growing in natural habitat, the edible bamboo shoot and sliced bamboo shoots. The **Fig. 5** shows the Cyanogen content in bamboo shoot for different pre-processing methods.

5. Critical inputs required:

- Simple, economic and effective method requiring only raw bamboo shoot, table salt and common heating/cooking items.

6. Observations to be recorded:

- Boiling for 20 minutes or pressure cooking for 15 min with 3% NaCl

7. Target users/stakeholders : MTTC/ KVKs/ Line department

8. Precaution(s) with the technology:

- Tip portion of the shoot should always be discarded.

9. Advantage/Benefits/Utility of the technology:

- Bamboo shoots are regarded as future health food due to its high nutritional content. The shoots are low in fats and cholesterol, high in dietary fibres and rich in mineral and amino acids content, however, bamboos are found to contain cyanogenic glycoside, a natural plant toxin
- By following the above processing method, it is observed that there is 85-90% reduction in cyanide level of the bamboo shoot. It is a simple, economic and effective method for reducing the cyanogenic content in bamboo shoot making it more favourable for human consumption and nutritional security.

10. Economics of the technology/ Benefit: Cost Ratio: The developed process cannot be expressed in monetary terms.

11. Technology developed under the project: Intra Mural Research Project (IRP) funded by CAU, Imphal *vide order no.* CAU-DR/3-6(Ag. Engg) 2010 dated 15/06/11.

12. Investigator(s)/inventor(s):

Amrit Chakma and Y Ranjana Devi: Email: amrit.chakma26@gmail.com; y_ranjana@yahoo.co.in, Mobile No. 9434028044.

13. Technology publication(s):

Devi, Y. R. and Chakma, A. (2014). Reduction of cyanogenic content in bamboo shoot during *Mesu* fermentation.*The Ecoscan*, **8**(3&4): 297-300.

Devi, Y. R.,Chakma, A. and Supriya, Y. (2017). Traditional wisdom of *Meitei* community regarding elimination of cyanogenic glycosides in bamboo shoot food products. *Indian Journal of Traditional Knowledge*, 16(3): 470-475.

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TECHNOLOGY:
NECTAR-PHT-113

1. **Name of the technology:** *Wadi* as value added product from squash (*Sechium edule*)
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2015
4. **Description of technology with salient features:**

Chayote squash or Chow-Chow (*Sechium edule*) belongs to gourd family Cucurbitaceae. It is a widely cultivated crop grown with least amount of investment. The crop is abundantly grown in the region of Meghalaya. It is known as Scot in Garo language. This crop is harvested during the period between June and October and is even exported outside the state, up to West Bengal. It is now gaining popularity as a food crop due to its inherent qualities. The fruits (**Fig. 1**) are rich source of amino acid and have adequate macronutrients and micronutrients. The fruits have diuretic, cardiovascular and anti-inflammatory properties.

Standardized recipe of *wadis* includes the following ingredients: *Scot* 200 g, black gram pastes 300 g (prepared by soaking 250 g black gram dhal in 750 ml of water for 3 hours), dried fenugreek leaves 3.5 g, coriander and cumin seeds 7.5 g, cinnamon 1.5 g, black and red pepper 3.0 g, nutmeg 0.25 g, asafetida 0.1 g.

Thick wet pulse paste is whisked continuously with a stainless-steel whisk to allow air incorporation that makes the paste light and fluffy. To the wet pulse paste, standardized amount of *Scot* (40% of the mix/amounting to 125 g *Scot*) and seasonings are added. This paste should be mixed thoroughly with flavorings. This fluffy batter is then divided into small balls weighing 40–50 g. The prepared balls should then be spread on stainless steel trays smeared with oil, maintaining a distance of 1–2 inch between balls. The trays are then loaded in hot air cabinet drier and dried at 60 ± 5 °C for 14-16 h. The prepared wadis (**Fig. 2**) should then be stored in an airtight plastic jar (500 g capacity).

Nutritional information:

a) Moisture: 5.8%

b) Carbohydrate: 6.56%

c) Protein: 19.91%

d) Ash: 3.03%

Fig. 1 Farm fresh squash

Fig. 2 Prepared *Wadi* from squash

e) Ascorbic acid: 22.063 mg 100 g^{-1}

Shelf life: 12 months from the date of preparation

5. Critical inputs/equipment/items required:

- Ingredients: Scot (*Sechium edule*) vegetable, split black gram dhal (*Phaseolus mungo* Roxb.) and whole spices (dried fenugreek leaves, coriander seeds, cumin, cinnamon, black pepper, red pepper, nutmeg and asafetida.
- Equipment:Blender, Hot Air Oven, Plastic bottles, Utensils

6. Observations to be recorded:

- Organoleptic properties *viz*. appearance, colour, flavour, taste etc.

7. Target users/ stakeholders: MTTCs / KVKs/ Consumers/ Farm women/ SHGs/NGOs

8. Precaution(s) with the technology:

a) Maintain personal hygiene

b) The working area, utensils and equipment need to be cleaned regularly.

c) The moisture content in the final product should not be higher than 6%.

d) Packaging should be done in airtight containers to avoid exposure to external moisture.

e) Follow prevalent GMPs for food processing as recommended by FSSAI.

9. Advantage/ Benefits/ Utility of the technology:

a) Novel value-added product from an underutilized vegetable has been formulated.

b) Shelf life of the perishable vegetable is increased by converting it into value added product.

10. Economics of the technology/ Benefit: Cost Ratio:

Total cost of production (Rs kg^{-1})	Selling price (Rs kg^{-1})	Net Income (Rs kg^{-1})	Benefit: Cost Ratio
110	190	80	1: 1.72

11. Technology developed under the project:

DST, GOI project entitled "Development of low-cost value-added processed products from squash (*Sechium edule*) and dissemination of technology to the tribal women of West Garo Hills District of Meghalaya"

12. Investigator(s)/inventor(s):

Puspita Das and Lokesh K. Mishra: Email: puspitameghalaya@gmail.com; lkmishra2005@gmail.com

13. Technology publication:

Mishra, L. K., Das, P. and Angela, G. (2017). Quality evaluation and storage studies of legume-based wadis (traditional delicacies) formulated using *Sechium edule*–An underutilized vegetable crop of North East India. *Research Journal of Biotechnology,* **12**(6): 29-36. (NAAS Rating: 6.24)

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TECHNOLOGY:
NECTAR-PHT-114

1. **Name of the technology:** Squash (*Sechium edule*) Pickle- a value added product
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2015
4. **Description of technology with salient features:**

Chayote Squash or Chow-Chow (*Sechium edule*) belongs to gourd family Cucurbitaceae. It is a widely cultivated crop grown with least amount of investment. The crop is abundantly grown in the region of Meghalaya. It is known as Scot in Garo language. This crop is harvested during the period between June and October and is even exported outside the state, up to West Bengal. It is an under-utilized vegetable consumed locally. However, it is gaining popularity as a food crop due to its inherent qualities. The fruits (**Fig. 1**) are rich source of amino acid and have adequate macronutrients and micronutrients. The fruits have diuretic, cardiovascular and anti-inflammatory properties. Procedure for making squash pickle (**Fig. 2**) is as given below:

1. Wash all the raw materials/vegetables with cold water and pluck/trim the unnecessary or unwanted materials (leaves, stems, seeds, others).
2. Peel off the outer skin of the vegetables and cut or dice into required sizes and shapes uniformly with the help of a knife.
3. Wash the pieces with cold water thoroughly.
4. Prepare a brine solution or salt solution (20% solution) in a big vessel (preferably made of high-grade steel) and immerse/soak the cut vegetables pieces into it for 4-5 days for the curing process to take place or till the vegetables become soft and tender.

   #Note that, the vegetable pieces should be fully immersed under the salt solution to acquire a good colour, flavour and texture etc.

5. Remove the cured vegetables out from the salt solution and let it dry partially in the sun for a minute or so/until the outer surface moisture decrease/reduce.
6. Take and weigh required quantities of whole spices and fry the spices on medium flame/heat with constant stirring/agitation.
7. Grind the spices to a coarse texture after cooling.
8. In a pan, heat the mustard oil well until the rawness or pungency smell reduces and leaves it to cool.
9. Thoroughly mix all the fried and ground spices, salt as well as other spices along with cured vegetables along with the cooled mustard oil and other ingredients.
10. Mix all the ingredients gently and thoroughly and add required amount of vinegar and remix the contents.
11. After all the ingredients are mixed properly, pack in a good, clean and sterilized bottles which should be kept it in a cool dark place.
12. **Shelf life:** 12 months from date of preparation

Fig. 1 Farm fresh squash

Fig. 2 Prepared pickle from squash

5. Critical inputs/equipment/ itemsrequired:

a) Raw materials required:		b) Spices and condiments:	
Squash	- 500 g	Turmeric powder	- 50 g
Cauliflower	- 500 g	Red chilli powder	- 50 g
French beans	- 150 g	Kashmiri mirch powder (for colour)	- 100 g
Carrot	- 200 g	Amchur/ mango powder	- 150 g
Radish	- 250 g	Methi	- 10 g
Lime	- 150 g	Black cumin	- 10 g
Ginger	- 20-30 g	Asafoetida	- 3 pinch
Garlic	- 20 g	Coriander powder	- 50 g
Green chilli	-50-100 g	Mustard seeds powder	- 30 g
Kasurimethi		Fennel/saunf	- 15 g
Black pepper		- as required	
Mustard oil		- 50 g	
Vinegar		- 1 l	
Salt (for curing)		- 50-100 ml	
		- 400 g	

6. Observations to be recorded

Organoleptic properties *viz*., appearance, colour, flavour and taste

7. Target users/stakeholders: MTTCs/ KVKs/Consumers/Farm women

8. Precautions with the technology:

a) Maintain personal hygiene.

b) The working area, utensils used in preparation should be cleaned properly.

c) Packaging should be done in an airtight container.

9. Advantage/ Benefits/ Utility of the technology:

a) Value added product from a perishable vegetable.

b) Economic benefits to the producer/ farmers.

10. Economics of the technology/ Benefit: Cost Ratio:

Total cost of production (Rs kg^{-1})	Selling price (Rs kg^{-1})	Net Income (Rs kg^{-1})	Benefit: Cost Ratio
80.00	130.00	50.00	1:1.62

11. **Technology developed under the project:**

    DST, GOI project entitled "Development of low-cost value-added processed products from squash (*Sechium edule*) and dissemination of technology to the tribal women of West Garo Hills District of Meghalaya".

12. **Investigator(s)/inventor(s):**

    Puspita Das: Mobile: 7005540038; Email: puspitameghalaya@gmail.com

13. **Technology publication(s):**

    Final Report submitted to DST, GOI.
    tasty

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TECHNOLOGY:
NECTAR-PHT-115

1. **Name of the Technology:** Osmo-dehydrated pineapple products (Ring and Titbits)
2. **Source of Technology:** COA (CAU, Imphal), Iroisemba, Manipur and CAEPHT (CAU, Imphal), Ranipool, Sikkim
3. **Year of adoption/development/ publication**: 2016
4. **Description of technology with salient features:**

The pineapple (*Ananas comosus*) is the most important horticultural plant of the family Bromeliaceae positioning as the important fruits in the world. India is one of the major producers of pineapples. Nearly 40% of the total pineapple production of the country comes from the NE region and 90 to 95% of the produce is organic. 'Giant Kew' and 'Queen' are the common cultivars grown in this region. Pineapple is very perishable horticultural commodity and its shelf life extension in raw fruit form is difficult. Several value-added products like osmo-dehydrated titbits (**Fig. 1**) and rings (**Fig. 2**) could be made out of pineapple.

After thorough cleaning of pineapple, they are peeled, sliced into 6-8 circular pieces with the help of stainless-steel pineapple peeler cum-corer cum slicer. The hard core is removed simultaneously in the process. The circular pieces are kept in hot water for 15 minutes for blanching and then the adhering water is drained out. The blanched pineapple slices are dipped in sugar syrup of 57-60°B for 8 hours (sugar @ 1.0 kg in 2 l of boiled and cooled water). Then pieces are removed and adhering syrup wiped up. Then the pieces are dried at 70°C for 24 hours in a tray dryer.

Fig. 1 Pineapple osmo dehydrated titbits

Fig. 2 Pineapple osmo dehydrated rings

5. **Critical Inputs/ equipment/ items required:**

a) Raw materials/Inputs : Pineapple, sugar, citric acid

b) Tools and machinery: S. S. pineapple peel cum corer cum slicer, S. S. knives, S. S. utensils, filtration unit, electronic balance.

c) Manpower : 02

d) Investment : Rs. 50,000

6. **Observations to be recorded:** Uniformity of cut slices, deformation of rings and titbits duringdrying, soaking time in sugar syrup.

7. **Target users/stakeholders:** Small Scale Industry/ SHGs/ NGOs/Farm women

8. **Precaution(s) with the technology:** 1. The pineapple should be graded into the 3 grades namely small, medium and large sizes 2. Required size of peeler-core-slicer must be selected to avoid losses alongwith the peel. 3.The shocked ring, titbit and other pineapple pieces should not be over dried.

9. **Advantage/ Benefits/ Utility of the technology:** The pineapple can be converted into value added products and stored for long time for atleast upto 5-6 months. The mass/volume of raw pineapple can be reduced by several folds from the point of transportability and marketability.

10. **Unit Cost** : 1. Osmo-dehydrated pineapple ring: Rs. 205 pcs^{-1}(100 g^{-1}) 2. Pineapple titbits: Rs. 15100 g^{-1}

11. **Commercialisation Status:** Commercialised

- No. of Licenses to whom the technology has been transferred: Private Industry
- Selected address of Licenses of Manufactures: Green Biotech Ecosolutions Pvt. Ltd, Imphal

12. **Technology developed under the project:**

- AICRP on PHET, ICAR-CIPHET, PAU, Ludhiana -141 004, India, and
- B.Tech. project entitled "Refinement of process technology for production of osmo-air dehydrated pineapple rings" submitted to CAU, Imphal for award.

13. **Investigator(s)/inventor(s):**

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14. **Technology publication:**

Jena, S., Mishra, S. and Agrawala, S. P. (2010). Osmo-air dehydrated pineapple rings: A value-added product". *CAU Research Newsletter*, **1**(1), pp: 12-13.

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TECHNOLOGY:
NECTAR-PHT-116

1. **Name of the technology:** Jackfruit chips – a value added products
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2016
4. **Description of technology with salient features:**

Jackfruit (*Artocarpus heterophylus*) is a typical Indian fruit found abundantly in Southern and North-Eastern part of India. It is widely used as a vegetable and when fully ripe, as a fruit. Jackfruit is highly underutilized and has tremendous scope for value addition. It is one of the most neglected tree crops grown in the state of Meghalaya and is found in abundance in Garo Hills region of the state. It is a promising potentially nutritious fruit rich in vitamin A, B and C besides potassium, calcium, iron, proteins and carbohydrates. The preparation of jackfruit chips is very simple and can easily be processed. The prepared chips can be stored at ambient condition keeping in Aluminium laminate pouches for two months without loss of organoleptic quality. Process protocol for preparation of jackfruit chips is presented below while **Fig. 1 & 2** respectively show the jackfruit bulbs cut into finger like shape and packed jackfruit chips.

Fully mature but unripe jackfruit

↓

Peeling and deseeding

↓

Deseeded bulbs
Cutting longitudinally into finger like pieces (approx. 4 x 1.5 cm slices)

↓

Blanching in hot water with 1% KMS for 5 -6 minutes

↓

Drying in drier (40 – 45^0 C for 10-15 min)

↓

Deep frying in cooking oil till it turns light brown colour

↓

Cooling

↓

Sprinkle required quantity of salt and chilli powder

↓

Pack in high density polyethylene bags and store

Fig. 1 Jackfruit bulbs cut into finger like shape

Fig. 2 Packed Jackfruit chips

5. **Critical inputs/ equipment/ items required:**

- **Ingredients for the preparation of jackfruit chips:**

  Fully matured but unripe deseeded bulbs, cooking oil, chilli powder, salt, potassium meta bi-sulphite

- **Equipment required:**

  Jackfruit chips cutting machine, deep fryer, sealing machine, etc.

- **Other items:** Fuel, labour, packing material

- **Types of Jackfruit suitable for Chips:** Thin Flakes with fine bulbs

6. **Observations to be recorded:**

1. Organoleptic properties
2. Shelf life

7. **Target users/stakeholders:**

   Multi Technology Testing Centers (MTTCs)/ KVKs/ Consumers/ Farm women/SHGs/NGOs

8. **Precaution(s) with the technology:**

- Following points to be kept in mind:
- Jackfruit chips are prepared from raw bulbs.
- The fruit should be mature enough.
- Fully matured, unripe and newly harvested jackfruit should be taken.
- Large size of fruit bulb is favoured.

9. **Advantage/Benefits/Utility of the technology:**

   Jackfruit is widely available in the region and its value addition is very limited. Processing matured bulbs into chips requires very few inputs and can be carried out at the household level too. It can boost local economy wherein consumers can be encouraged to buy local healthier alternatives to packed potato chips.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1:1.25

11. **Technology developed under the project:**

    DBT, GOI, New Delhi funded project entitled "A value chain on Jackfruit and its value-added products".

12. **Investigator(s)/inventor(s):**

    Natasha Marak: Email: natasha.marak@gmail.com; Mobile: 8974041412

13. **Technology publication:**

    Final 'Project Report' submitted to the DBT, GOI, New Delhi.

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TECHNOLOGY:
NECTAR-PHT-117

1. **Name of the technology:** Jackfruit squash a value-added product-
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2016
4. **Description of technology with salient features:**

Jackfruit (*Artocarpus heterophylus*) is a typical Indian fruit found abundantly in Southern and North-Eastern part of India. It is widely used as a vegetable and when fully ripe, as a fruit. Jackfruit is highly underutilized and has tremendous scope for value addition. It is one of the most neglected tree crops grown in the state of Meghalaya and is found in abundance in Garo Hills region of the state. It is a promising potentially nutritious fruit rich in vitamin A, B and C besides potassium, calcium, iron, proteins and carbohydrates.

Procedure for making jackfruit squash (**Fig. 1**) is as described below;

Ripe deseeded jackfruit bulbs are taken

↓

Blanching in boiling water for few second

↓

Blending in a mixer / grinder is done to get pulp

↓

Squash preparation- The ratio should be pulp (128 g), water (500 ml), sugar (230 g) and citric acid (2-2.5 g)

↓

The mixture is boiled at 85 to 90° C for 10 – 15 m

↓

The mixture is cooled and filtered KMS at the rate of 200 ppm (0.2 g) is added

↓

The squash is then filled into sterilized glass bottles and sealed

↓

Pasteurization (80 – 85° C) is done for 20 minutes and then stored.

Fig. 1 Finish product of jackfruit squash

5. **Critical inputs/ equipment/items required:**

• Fully ripe jackfruit bulbs	• Sugar
• Citric acid	• KMS (preservative)
• Squash making machine (for industrial production)	• Boiler
• Pulping machine	• Homogenizer
• Food grade bottles.	

7. **Observation to be recorded:**

- Organoleptic properties

8. **Target users/stakeholders:**

MTTCs/ KVKs/ Consumers/ Farm women/SHGs/NGOs

9. **Precaution(s) with the technology:**

Select fruits meeting the following criteria:

- Hollow sound on tapping.
- Spines and skin become flattened and wider.
- Deeper the colour, higher the acceptability
- Fruit develops strong aroma.
- Ripe fruit containing high TSS (< 10 degree Brix) and thick pulp.

10. **Advantage/ Benefits/ Utility of the technology:**

Value addition of ripe jackfruit into squash provides an excellent avenue for use of ripe bulbs which otherwise have low shelf life. It provides for a refreshing summer drink packed with vitamins and minerals.

11. **Economics of the technology/ Benefit: Cost Ratio:** 1: 1.37

12. **Technology developed under the project:**

DBT, GOI, New Delhi funded project entitled "A value chain on Jackfruit and its value-added products".

13. **Investigators/ inventors:**

N. Marak and A. Kumar: Email: natasha.marak@gmail.com; Mobile: 8974041412

14. **Technology publication:**

Final 'Project Report' submitted to the DBT, GOI, New Delhi.

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TECHNOLOGY:
NECTAR-PHT-118

1. **Name of the technology:** Jackfruit Papad -a value added product
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2016
4. **Description of technology with salient features:**

Jackfruit (*Artocarpus heterophylus*) is a typical Indian fruit found abundantly in Southern and North-Eastern part of India. It is widely used as a vegetable and when fully ripe, as a fruit. Jackfruit is highly underutilized and has tremendous scope for value addition. It is one of the most neglected tree crops grown in the state of Meghalaya and is found in abundance in Garo Hills region of the state. It is a potential nutritious fruit rich in vitamin A, B and C besides potassium, calcium, iron, proteins and carbohydrates.

Procedure for making jackfruit papad is described below through process chart:

De-seeded bulbs from fully matured jackfruit

↓

Washing in water with preservative, Potassium Metabisulfite (KMS) (0.1%)

↓

Steam cooking (3 whistles in a home pressure cooker)

↓

Grinding to a pasty pulp

↓

Addition of spices

↓

Portioning

↓

Rolling/ Spreading

↓

Drying of Papad

↓

Packaging and storage

Fig. 1 shows the drying of jack fruit papad in a commercial dryer while **Fig. 2** shows the use of a ready-made dice to give circular shape to papads, **Fig. 3** shows the finished and packed papad.

Fig.1 Drying in a commercial dryer

Fig. 2 Using ready-made dice to create circles

Fig. 3 Finish product of Jackfruit papad

5. **Critical inputs/ equipment/ items required:**

- Pressure cooker
- Mixer grinder
- Papad making machine for large scale production
- Commercial dryer/ solar dryer
- Spices, salt
- Preservative (0.1% KMS, white crystalline powder used as an antioxidant and sanitizer)

6. **Observations to be recorded:**

1. Organoleptic properties
2. Blood sugar level test (before and after feeding the developed product)

7. **Target users/stakeholders:**

MTTCs/ KVKs/Consumers/ Farm women/SHGs/NGOs

8. **Precaution(s) with the technology:** Select fruits which meet the following criteria:

- Fully matured but unripe
- Bulbs should be easily extractable
- Thick pulp and less of total Soluble solids (TSS). The TSS can be measured using a refractometer and values should be for acceptance of the fruit.
- High bulb content

9. **Advantage/Benefits/Utility of the technology:**

Excellent alternative to commercially available papads prepared from pulses.

10. **Economics of the technology/ Benefit: Cost Ratio:** 1:1.27

11. **Technology developed under the project:** DBT, GOI, New Delhi funded project entitled "A value chain on Jackfruit and its value-added products".

12. **Investigators/ inventors:**

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13. **Technology publication:**

Final 'Project Report' submitted to the DBT, GOI, New Delhi.

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TECHNOLOGY:
NECTAR-PHT-119

1. **Name of the technology:** Ready-to-cook (RTC) value added products of jackfruit
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2016
4. **Description of technology with salient features:**

Jackfruit (*Artocarpus heterophylus*) is a typical Indian fruit found abundantly in Southern and North-Eastern part of India. It is widely used as a vegetable and when fully ripe, as a fruit. Jackfruit is highly underutilized and has tremendous scope for value addition. It is one of the most neglected tree crops grown in the state of Meghalaya and is found in abundance in Garo Hills region of the state. It is a promising potential nutritious fruit rich in vitamin A, B and C besides potassium, calcium, iron, proteins and carbohydrates. Tender jackfruit is popular for vegetable purposes and can be sold in the form of minimally processed slices or as a whole. The shelf life of Ready-To-Cook (RTC) product is only a day or two at room temperature. Certain treatments are known to increase its shelf life. Tender fruits appear in the market in spring and continue till late summer as popular vegetable. The market for RTC Jackfruit looks very encouraging and it could be sold in vegetable shops, supermarkets and weekly vegetable markets. The protocol for minimally processed tender Jackfruit Ready to Cook (RTC) is as follows:

Collection of healthy green jackfruits

↓

Washing in 1% KMS solution

↓

Removal of outer surface portion of spines

↓

Washing with 1% KMS solution

↓

Cutting into required sizes

↓

Dipping in warm water (50 – 60°C) with 0.5% KMS

↓

Pre-treatment with 0.5% citric acid followed by air drying

↓

Packaging and storing

Fig. 1 Unripe jackfruits

Fig. 2 Cutting into required sizes

Fig. 3 RTC value added product of jackfruit

Figs. 1 to 3 show the various steps required in preparing jack fruit RTC product.

5. Critical inputs/equipment/items required:

- Select suitable variety
- Appropriate preservatives (KMS) in appropriate quantity

5. Observations to be recorded:

- Organoleptic assessment/test
- Shelf life assessment

6. Target users/stakeholders:

MTTCs/ KVKs/ Consumers/ entrepreneurs / farmers

7. Precaution(s) with the technology: Fruit should meet following criteria:

- Fruit should be tender and without disease
- Less milky latex
- Less core
- More pulp

8. Advantage/Benefits/Utility of the technology:

Consumers are provided with a ready to cook food item without the hassle of cutting the fruit, which is cumbersome since jackfruit contains latex. Intake of the fruit will also increase for this very reason, providing an alternative to meat (vegan substitute).

9. Economics of the technology/ Benefit: Cost Ratio: 1: 1.27

10. Technology developed under the project:

DBT, GOI, New Delhi funded project entitled "A value chain on Jackfruit and its value-added products".

11. Investigator(s)/ inventor(s):

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12. Technology publication:

Final 'Project Report' submitted to the DBT, GOI, New Delhi.

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TECHNOLOGY:
NECTAR-PHT-120

1. **Name of the Technology:** Aloe vera based Ready-To-Serve (RTS) drink blended with ginger, amla and sweet lime
2. **Source of Technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development**: 2017
4. **Description of technology with salient features:**

The product is an RTS Drink developed from locally available inputs like Aloe vera, ginger, amla and sweet lime.

a. Ingredients/items

- Aloe vera
- Sweet lime juice
- Sugar
- Sodium meta bisulphite (Preservative)
- Ginger extract
- Amla extract
- Citric acid
- Bottle with label

b. Methodology:

For preparation of 10 litres of 'Aloe vera RTS blended with ginger, amla and sweet lime' following steps should be followed:

Fresh Sweet Lime (10 Nos.)	Matured aloe vera leaves (15 No. approx. 5 kg^{-1})	Fresh Ginger (300 g)	Fresh Amla (1125 g)	Sugar Syrup
↓ Wash and Peel	↓ Wash	↓ Wash	↓ Wash	↓ Water (7280 ml)
↓ Cut into halves	↓ Cut tips/edges	↓ Slice	↓ Extract pulp	↓
↓ Juice extracted	↓ Peel and extract gel	↓ Grind	↓ Grind to extract juice	↓ Sugar (1.2 kg)
↓ Clear Juice (150 ml)	↓ Filtering gel	↓ Extract and Filter juice	↓ Filter	↓ Boil till sugar dissolves
	↓ Clear Gel (1050 ml)	↓ Clear juice (75 ml)	↓ Clear juice (225 ml)	

Mix the ingredients in the ratio of
Aloevera (70): Ginger (5): Sweet lime (10): Amla (15)
For 10 l final product
(Aloe vera 1050 ml + Ginger juice 75 ml + Sweet Lime juice 150 ml + Amla juice 225 ml + Sugar syrup 8500 ml for 10 l final product)

For 100 ml final product
(Aloe vera 10.5 ml + Ginger juice 0.75 ml + Sweet lime juice 1.5 ml + Amla juice 2.25 ml + Sugar syrup 85 ml for 100 ml final product)

← Filtered sugar syrup (8500 ml)

↓

Blended RTS (10 litres)
(Brix: 15°, TSS: 15%, Acidity: 0.2%, KMS: 100 mg l^{-1})
Citric acid: 20 g, KMS = 1.7 g

↓

Bottlein clean dry vapour sterilized air-tight bottles
(50 bottles of 200 ml each)

↓

Sterilization of sealed bottles
in boiling water for 10 min

↓

Storing under refrigerated conditions
(Best before 2 months from the date of preparation

Fig. 1 Flow chart shows the process of preparation of aloe vera RTS drink

Fig. 2 Aloe vera RTS drink packed in bottles and ready for serving or marketing

c. Nutritional information (per 100 ml juice):

1. Energy – 68.66 kcal
2. Carbohydrate – 16.84 g
3. Protein – 0.32 g
4. Fat – Nil
5. Vitamin C – 104.3 mg

d. Shelf life: Best before 02 months from date of preparation

5. Critical Inputs/equipment/items required:

- Filtration unit
- Sensitive balance
- Juice extractor
- Homogenizer
- Appropriate Utensils
- Pure water

6. **Observations to be recorded:** Organoleptic properties, shelf life (Best before 02 months from date of preparation)

7. **Target users/stakeholders:** Small Scale Industry/ SHGs/ NGOs/Farm women

8. **Precaution(s) with the technology:**

- Maintain personal hygiene
- The working area, utensils, equipment need to be cleaned regularly.
- Follow prevalent GMPs for juice processing as recommended by FSSAI.

9. **Advantage/Benefits/Utility of the technology:**

- Value added product from locally available raw materials
- Extension of shelf life of perishable agri-produce.

10. **Economics of the technology/ Benefit: Cost Ratio:**

Total cost of production (Rs l^{-1})	Selling price (Rs l^{-1})	Net Income (Rs l^{-1})	Benefit: Cost Ratio
70.00	150.00	80.00	2.14

11. **Technology developed under the project:** Ministry of Food Processing and Industries, GOI funded project entitled "Low cost process development and quality evaluations of carbonated beverages made from Aloe vera Gel Blend with extract of Amla, Sweet Lime & Ginger in Meghalaya – North East Region".

12. **Investigator(s)/inventor(s):** Lokesh K Mishra: Email: lkmishra2005@gmail.com; Mobile: 9863068698.

13. **Technology publication:**

Mishra, L. K. and Sangma, D. (2017). Quality attributes, phytochemical profile and storage stability studies of functional ready to serve (RTS) drink made from blend of *Aloe vera*, sweet lime, *amla* and ginger. *Journal of Food Science and Technology*, **54** (3): 761-769. (NAAS Rating- 7.85).

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TECHNOLOGY:
NECTAR-PHT-121

1. **Name of the Technology:** Pineapple ready-to-serve (RTS) drink blended with ginger cinnamon
2. **Source of Technology:** COA (CAU, Imphal), Iroisemba, Manipur
3. **Year of adoption/development**: 2018
4. **Description of technology with salient features:**

The product is an RTS drink developed from pineapple, organically produced ginger and cinnamon.

Methodology:

For preparation of 10 litres of 'Pineapple RTS drink blended with ginger or cinnamon (**Fig. 1**) following steps have to be followed:

Fresh pineapple (8 kg)	Fresh Ginger (60 g)	Cinnamon (40 g)	Sugar Syrup
Removing of crown and stalk	Washing and peeling	Washing	Water(7.0 l)
Washing	Slicing	Crush into small particles	Sugar (1.4 kg)
Peeling, Coring, Cutting into slices, Cubes	Grinding	Dissolving in warm water 50 ml	Add citric acid 15 g
Juice extraction in screw extractor	Mixing with water (60 ml)	Boil for 3min.	Water-Sugar syrup (7500 ml)
Filtering	Boil for 3min.	Filtering	
Clear Juice (2500 ml)	Filtering	Clear extract (40 ml)	
	Clear extract (50 ml)		

Mixing the ingredients in the ratio (25:74:1:: Pineapple juice: water-sugar syrup: Ginger or cinnamon extract) for 10 l final product

↓

Blended RTS (10 l)
(TSS – 15˚ Brix, Acidity – 0.2%)

↓

Bottling and Capping
(50 bottles of 200 ml each)

↓

Sterilization of sealed bottles
in Autoclave for 15 psi, 121˚C and 15 min

↓

Immediately cool in running water
Labelling of the glass bottles

↓

Storing under refrigerated conditions
(Best before 3 months from the date of preparation

Fig.1 Pineapple RTS drink blended with ginger, Cinnamon

5. Critical inputs/equipment/items required:

a) Raw materials/ inputs : Pineapple, sugar, citric acid

b) Tools and machinery: S. S. pineapple peel cum corer cum slicer, S. S. knives, S. S. utensil, filtration unit, electronic balance, juice extractor, autoclave.

c) Man power : 02

d) Investment : Rs. 1,50,000

6. Observations to be recorded: Juice recovery percent during the extraction, Sterilisation time (autoclave) of the bottle as well as RTS drink, Temperature and pressure of the autoclave.

7. Target users/stakeholders: Small Scale Industry/ SHGs/ NGOs/Farm women

8. Precaution(s) with the technology: 1. Mature and ripe pineapple fruits to be selected 2. Juice extraction must be done in stainless screw extraction machine 3. Required size of peeler-core-slicer must be selected to avoid losses alongwith the peel. 3.Required proportion of sugar, ginger extract, cinnamon must be added.

9. Advantage/Benefits/Utility of the technology: The fresh pineapple can be converted into fresh Juice (RTS and squash) and stored for long time for atleast upto 3-4 months. The flavour of the juice can be enhanced by blending with organically ginger/cinnamon.

Unit Cost : Pineapple RTS: Rs. 20 per 200 ml drink

Commercialisation Status : Commercialised

a) **No of Licenses to whom the** : Private Industry technology has been transferred

b) **Selected address of Licenses** : Green Biotech Ecosolutions Pvt. Ltd., Imphal of Manufactures

10. Technology developed under the project: AICRP on PHET, ICAR-CIPHET, PAU, Ludhiana -141 004, India

11. Investigator(s)/inventor(s):

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TECHNOLOGY:
NECTAR-PHT-122

1. **Name of the technology:** Low glycemic index (GI) *roti* mix
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2019
4. **Description of technology with salient features:**

The glycemic index (GI) is a number ranging from 0 to 100 assigned to a food, which represents the relative rise in blood glucose level two hours after consuming food. Food which has low GI will be considered as healthier. Hence a roti mix using locally available farm products has been developed. Physicochemical analysis shows that the mix is rich in dietary fibre. Low 'GI Roti mix' was prepared with whole wheat flour and dehydrated squash powder, in 90 : 10 proportion. Organoleptic tests were taken for the entire developed product. The **Fig. 1** shows Roti prepared from this mix.

Preparation of squash powder: The process of preparation of roti mix is as shown below;

Squash peeling deseeding dehydration grinding sieving mixing with whole wheat flour

Nutrient/Proximate composition of the products (low GI mix):

The developed mix contained high micro & macro minerals as well as low Glycemic index value of 46.05.

Product	Moisture (g)	Protein (g)	Fat (g)	Ash (g)	Crude fibre (g)	CHO (g)	Energy (Kcal)	Total Dietary fibre (g)	Ca (mg)	Fe (mg)	Zn (mg)
Low GI Roti	6.21	10.75	1.79	1.88	0.87	79.37	376.59	16.12	120.09	31.37	14.20

Sensory evaluation:

Product Name	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Low GI mix for roti	8	8	8	8	8	8

Fig. 1 Prepared roti from low GI mix

5. **Critical inputs/ equipment/ items required:** Wheat flour, squash
6. **Observations to be recorded:**

- Organoleptic properties
- Blood sugar level test (before and after feeding the developed product)

7. **Target users/stakeholders :** MTTCs/ KVKs/Consumers/Farm women

8. **Precaution(s) with the technology:**

   Sanitary conditions should be maintained while making squash powder.

9. **Advantage/Benefits/Utility of the technology:**

   Product prepared from low GI roti mix will be useful for all age group in general, however, product will be highly beneficial for diabetic patients.

10. **Economics of the technology/ Benefit: Cost Ratio:**

    As the raw materials are cheap and easily available the technology will be beneficial for the population. Squash is locally available. Cost calculation was done for roti mix. The cost of developed mix is Rs 45.7 kg^{-1}.

11. **Technology developed under the project:** All India Coordinated Research Project (Food Science & Nutrition Component), ICAR

12. **Investigator(s)/ inventor(s):**

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TECHNOLOGY:
NECTAR-PHT-123

1. **Name of the technology:** Low glycemic index (GI) *upma* mix
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2019
4. **Description of technology with salient features:**

There are estimated 72.96 million cases of **diabetes** in adult population of **India**. The **prevalence** in urban areas ranges between 10.9% and 14.2% and **prevalence** in rural **India** was 3.0-7.8% among population aged 20 years and above with a much higher **prevalence** among individuals aged over 50 years.

Food which has low GI is considered as healthier for both diabetic patients and even for normal individuals. Physicochemical analysis shows that the mix which has been developed and is presented here is rich in dietary fibre. This low 'GI *Upm* mix' is prepared with semolina, foxtail millet and squash powder mix. The composition of the Upma mix is: Semolina: 65 g, Foxtail Millet: 20 g, Squash powder: 15 g. Organoleptic test (sensory evaluation) indicated that the mix has high acceptance levels.

Preparation of upma mix: The process chart for preparation of low GI *Upma* mix is shown below:

Squash → Peeling → Deseeding → Slicing in 3 cm thick → Dehydration (65°C for 7-8 h) → Grind fully dried squash → Sieving Mixing with semolina & Foxtail millet*

*Preparation of Foxtail Millet → Cleaned → Grinded to 150-350 µm

Sensory evaluation:

Product Name	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Low GI mix for *upma*	9	9	9	9	9	9

Fig. 1 & 2 Different preparations of *Upma* out of the Low GI mix

Table 1 Nutrient composition of the products prepared from the modified low GI mix (GI= 49)

Name of the product	Moisture (g)	Protein (g)	Fat (g)	Ash (g)	Crude fibre (g)	CHO (g)	Energy (kcal)	Total Dietary fibre (g)	Ca (mg)	Fe (mg)	Zn (mg)
Low GI *Upma*	8.50	8.85	1.59	1.23	0.67	79.83	369.03	14.25	82.41	22.14	10.74

Remark

When the fresh semolina (Semolina is a product of wheat, per 100 g semolina gives 73 g of carbohydrate and from carbohydrate only we get sugar in the blood) based *upma* was prepared, the value of dietary fibre was estimated to be approximately 3.9 g 100 g^{-1} of semolina, however, in the developed mix, it showed to be 14.25 g 100 g^{-1} which is very high. The target was to reduce the total carbohydrate content of the product along with the slow release of sugar in the body. So instead of using plain semolina we added millet (foxtail) and vegetable i.e., squash powder after dehydration and grinding as millet and vegetable have got more fibre, the total dietary fibre value of the product has also increased.

It served two purposes, one side reduces the total carbohydrate content per 100 g and it increases the total dietary fibre content of the product. Due to the increase in dietary fibre, the slow release of sugar takes place in the human body. The value of dietary fibre shown in **Table 1** is the result of the chemical analysis of the developed mix by following standard procedure. The human feeding trial also shown the product has got a slow release of blood sugar and the Glycemic Index (GI) of the prepared product is 49. Any value below 55 is considered low GI. The 'Glycemic Index' is an indicator of the ability of different types of foods that contain carbohydrates to raise blood glucose levels within two hours. Foods containing carbohydrates that break down most quickly during digestion have the highest glycemic index.

5. **Critical inputs/equipment/items required:** Foxtail millet, semolina, squash
6. **Observations to be recorded at the time of implementation of technology:**

1. Organoleptic properties
2. Blood sugar level test (before and after feeding the developed product)

7. **Target users/stakeholders:**

   MTTCs / KVKs / Consumers / Human Consumers/Farm women
8. **Precaution(s) with the technology:** Sanitary conditions should be maintained while making squash powder.
9. **Advantage/Benefits/Utility of the technology:** Product prepared from low GI *upma* mix will be useful for all age group in general, however, product will be highly beneficial for diabetic patients.
10. **Economics of the technology/ Benefit: Cost Ratio:** As the raw materials are cheap & easily available, developed the technology will be beneficial for the population. Squash& foxtail millets are locally available. The cost calculation was done for upma mix. The cost analysis of the developed mix is Rs 50.3 kg^{-1}.
11. **Technology developed under the project:**

    ICAR- All India Coordinated Research Project (Food Science & Nutrition Component)
12. **Investigators/ inventors:** Namita Singh: Mobile No.: 9089732296; Email: drnam2007@rediffmail.com

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TECHNOLOGY:
NECTAR-PHT-124

1. **Name of the technology:** Low glycemic index (GI) *cheela* mix
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2019
4. **Description of technology with salient features:**

Diabetic patients can live a normal life with slight change in their diet & life style practices. Glycemic index of food help in maintenance of normal blood sugar level of patient .Plantain flower and cow pea leaves are available in NE Region throughout the year. The present mix is prepared using these materials. Method was standardized to dehydrate plantain flower with minimum browning in order to retain good colour of recipe.

Plantain flower powder:

Remove outer hard layer of plantain flower → Cut in to slices → Cut slices are immersed in a citric acid solution for 30 min. → Solution is drained → Slices are oven dried at 75°C for 7 hours → Dried slices grind and make into fine powder → Sieving (ready to use powder).

Cowpea leaves powder preparation:

Leaves cleaned and washed → Blanched for 2 mins at 100°C → Drained water, thereafter cooling and Oven dry at 50°C for 8 hours (dehydration) → Grinding to fine powder and sieving and mixing with plantain flower powder → ready to use.

Preparation of Cowpea Beans:

Boiled for 40 minutes in 2500 ml water at 100°C → Water is drained and oven dried at 60°C for 8 hours → Grind the dried samples to fine powder.

Recipe of low GI *cheela* mix:

The following ingredients were taken to develop 100 g mix:

1. Plantain flower powder (g)	15
2. Cowpea powder (g)	30
3. Cowpea leaves powder (g)	5
4. Besan (Bengal gram powder) (g)	50

Sensory Evaluation of the mix:

Product Name	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Low GI *Cheela* mix	9	9	9	9	9	9

Nutrient composition of the products prepared from the modified low GI mix:

Name of the product	Moisture (g)	Protein (g)	Fat (g)	Ash (g)	Crude fibre (g)	CHO (g)	Energy (kcal)	Total Dietary fibre (g)	Ca (mg)	Fe (mg)	Zn (mg)
Low GI cheela	8.42	16.76	4.07	2.67	0.65	68.08	375.99	15.23	249.65	7.16	49.03

Note: Human feeding trial have shown glycemic index- 48

Fig. 1 Low GI *cheela* mix

Fig. 2 Product prepared out of the low GI *cheela* mix

5. Critical inputs/ equipment/ items required:

- Plantain flower powder
- Cow pea powder
- Cow pea leaves powder
- gram flour

6. Observations to be recorded:

1. Organoleptic properties
2. Blood sugar level test (before and after feeding the developed product)

7. Target users/stakeholders: MTTCs/ KVKs/ Consumers/ Human

8. Precaution(s) with the technology:

Hygienic practices to be followed while drying, powdering& mixing of different ingredients.

9. Advantage/ Benefits/ Utility of the technology:

Developed mix is a good source protein and dietary fibre, however, other nutrients are also present in appreciable amount. In comparison to traditional *cheela* preparation, which has only 11 g dietary fibre 100 g^{-1} of gram flour, the present *cheela* mix has a dietary fibre of 15.23 g 100 g^{-1}. Presence of high amount of dietary fiber makes the product suitable for all age group especially for a diabetic patient.

10. Economics of the technology/ Benefit: Cost Ratio:

As the raw materials are cheap and easily available the technology will be beneficial for the population of North Easter Region. The cost calculation was done for *cheela* mix and it is only Rs 135.6 kg^{-1}.

11. Technology developed under the project:

ICAR- All India Coordinated Research Project Food Science & Nutrition Component

12. Investigator(s)/inventor(s):

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TECHNOLOGY:
NECTAR-PHT-125

1. **Name of the Technology:** Process protocol for preparation of pineapple powder with natural aroma

2. **Source of Technology:** COA (CAU, Imphal), Iroisemba, Manipur & CAEPHT (CAU, Imphal), Ranipool, Sikkim

3. **Year of adoption/development**: 2019

4. **Description of technology with salient features:**

There is high consumer demand for fresh fruit products in India because of preference, nutritional requirement and changing food habits. Pineapple is one of the most priced and desired table-top fruits due to its aroma, taste and nutritional value. Fruits of pineapple are bulky and heavy, hence transportation from remote areas to the market is tricky and difficult and a large number of fruits get spoiled. Ripe pineapple fruits perish quickly at room temperature and also cannot be stored in the refrigerator for long periods as they are chill sensitive. Because of short storage time they need to be processed for long term preservation to make them conducive for human consumption. Owing to the problem of bulk handling, transportation and accompanying losses, pineapple powder can be a valuable alternative for reducing the wastage, and will give high economic returns to pineapple producers. The powder with natural aroma can increase the shelf-life substantially and can be used for making ready-to-mix powder in a dilute form.

Protocol for preparation of pineapple powder with natural aroma:

The following procedure is followed in batches.

- 105 l of pineapple juice is obtained (at 14^0 Brix) from the pulp of 300 kg pineapple by helical juice extractor.
- The pineapple juice is concentrated up to 50 l at 40^0 Brix using a two-stage falling film evaporator.
- Approximately 1.0 kg aroma components at 1% of raw juice w/w are recovered using the aroma recovery system in cohesion with the evaporator.
- Liquid glucose (10% of raw juice w w^{-1} at 85^0 Brix) as a carrier and sodium alumino silicate (1% of raw juice w w^{-1}) as an anti-caking agent is added to the concentrated juice.
- The juice mix (concentrated mix) is spray dried.
- The spray drying of the concentrated juice mix is carried at an inlet air temperature of 160^0C and out let air temperature of 90^0C with a feed of 120 ml min^{-1}.
- 10kg pineapple powder (at 3% moisture content) is obtained per 105l of juice after spray drying.
- 1.0 kg natural aroma component recovered is dosed/blended to the pineapple powder in the fluidised bed dryer.
- 10 kg pineapple powder (at approx. 3% moisture content) with natural aroma, colour and test is thus produced.
- The pineapple powder thus obtained is packed using a form-filling machine with a shelf-life of more than six months at ambient storage condition.

5. **Critical inputs/ equipment/ items required:**

Fig. 1 Pineapple processing plant at COA

Fig. 2 Pineapple powder package (30 g pouch)

a) **Raw materials/Inputs** : Pineapple, liquid glucose, sodium alumino silicate

b) **Tools and machinery** : The main machinery for continuous batch processing has the following main components which are integrated into a complete processing plant. A mobile primary processing van consisting of semi-automatic S. S. peeler cum corer, S. S screw extractor, S. S. slicer, Storage tank of 200 l, hydraulic press and skin stripper, S.S. knives, S. S. utensils, Filtration unit, Electronic balance, Juice extractor, form fill packaging machines.

c) Power requirement : 80 kwh power consumption, 3 phase connection or alternatively generator set of power/fuel requirement

   i) Primary processing van : 4 l of diesel h^{-1} of operation

   ii) Pineapple powder making plant: 6.0 l of diesel h^{-1} of operation

d) Manpower : 4

e) Investment : Rs. 1.5 crores

6. Observations to be recorded: Juice recovery per cent during extraction, Powder recovery, feed rate of juice into the spray dryer, pressure and inlet/outlet temperature of the juice.

Target users/stakeholders: Medium to large Scale Industry/NGOs/SHGs

7. Precaution(s) with the technology:

- The pineapple fruits to be washed thoroughly and should be graded into the grades; small, medium and large sizes. Different size of pineapple skin peeling cone (medium and large cone size) must be fitted depending upon the fruit size.
- Required size peeler-core-slicer must be selected to avoid losses along with the peel.
- Correct proportion of glucose and sodium alumino silicate must be mixed to bring to the foam conditions of juice.
- Packaging of the powder must be done as soon as the powder is obtained.

- The whole processing should be done in near aseptic and clean conditions.

8. **Advantage/Benefits/Utility of the technology:** The pineapple can be converted into powder form with natural aroma, colour and taste of the fruit juice. The shelf life of the pineapple can be enhanced to at least 6 months by converting into powder form.

9. **Unit Cost:** Pineapple powder: Rs. 800 kg^{-1} of powder

10. **Technology developed under the project:** Fund received from university.

11. **Investigator(s)/inventor(s):** Ng. Joykumar Singh, P. T. Sharma, Y. Jekendra Singh, S. Mishra and P. K. Srivastava: Email: joyngang@gmail.com; Mobile: 9612168301.

12. **Technology publication(s):**

Srivastava, P. K., Mishra, S., Yadav, S. N. and Gupta, R. (2013). Selected Bankable Technologies for Promotion of Agro-Industries in, NEH Region. 2013 (compiled by CAEPHT –CAU. Ranipool, Gangtok. (Publication No. CAU/CAEPHT/PRINTING / 2013/1).

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TECHNOLOGY:
NECTAR-PHT-126

1. **Name of the technology:** Textile fiber extraction and yarn preparation from Arecanut husk agro-waste
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2019
4. **Description of technology with salient features:**

Arecanut (*Areca catechu* Lin.) plays significant role in the livelihood of the Meghalaya. Arecanut husk is an agricultural-by product or residue which may be used to develop eco-friendly textile materials as well as an income generating activity for farm women. Transformation of husk into textile fiber brings sustainability in the industry and also helps to solve the problems of waste accumulation. Present technology envisages exploring the possibilities of utilizing plant biomass for fiber extraction and further textile applications.

Processing of fiber

Arecanut husk from mature fruits is collected and processed for fiber extraction. Normally, inside nuts are used whereas the epidermis of the fruit is discarded as waste or used as firewood. This outer husk is a rich source of cellulose that has potential use for textile applications. Urea and water retting method can beemployed for extraction of fiber from theouter husk and fibers separated manually by hand stripping method. Various steps involved in extraction of fiber are detailed below:

a. **Pre-treatment and retting-** Arecanut husk is treated with 2% urea and steeped in water for 3 to 5 days.

b. **Mechanical extraction-**Treated husk is washed thoroughly with water and dried for 2-3 days. Thereafter, fibre from the husk can be separated manually by hand stripping method.

c. **Scouring-** Scouring of extracted fibre is carried out with 2.5% of NaOH, 1% Turkey red oil in MLR of 1:50 at 60 ^{0}C temperature for 30 mins.

d. **Bleaching-** Scoured fiber is bleached using 2% Hydrogen peroxide and 1.5% sodium silicate, 0.5% teepol and 1% turkey red oil in MLR of 1:50 at temperature 100ºC for 60 mins.

Fiber properties

Length of mature arecanut husk fiber is 3 to 4 cm with linear density of 1.2 cN/tex. Length of fiber is directly proportional to the size of nut shell. Further, tenacity of fiber is 16.96 cN/tex with elongation percentage of 44.25%. Arecanut husk fibre comprises of 57.2% cellulose, 48% hemicellulose, 14.25% lignin and 2.726% ash. The tenacity value of arecanut husk fibre is comparable to woollenised jute.

On the basis of these quality parameters, Arecanut textile material could be used for various technical textile applications viz. apparel manufacturing in clothtech and hometech, composites for various application, mulching material in Agro-tech, as substitute of jute in Geo-textile, fillers and low buoyancy material in Automobile- textile, packaging, sanitary napkins and non -woven fabrics in medical textiles etc. Mainly two types of fibers are present – one very coarse (Grade-II) and the other very fine (Grade-I). The coarser ones are ten times coarser than jute. These fibers

adjoining the inner layers are irregularly lignified group of cells called hard fibers. The portions of the middle layer below the outermost layer are soft fibers, which are very similar to the jute fibers. New applications of agri waste fibers, like Arecanut husk fibers, will contribute to better management of agri-waste and facilitate sustainability.

Preparation of yarn

As Arecanut fiber has lot of buoyancy and is very soft hence it is difficult to process between carding rollers, hence it is blended with 30% cotton fibers for easy processing. Arecanut husk fiber has to undergo the sequential processes i.e. opening, carding and spinning to prepare the strong and uniform hand spun yarn and the processes are detailed below:

a. **Opening and blending-** The fibers are passed slowly in the opening machine, where the compact layer of fibers is converted into light and fluffy tufts and foreign materials are removed from the fibers. Arecanut fiber is blended with cotton fiber for easy processing into 70:30 (Arecanut: cotton) ratio.

b. **Carding-** Carding machine is used which is composed of three cylinders. These cylinders are covered with the heavy fabric embedded with bent wires. The bent wire separates the fiber from the bundle, removes the vegetable matter from the fibers and straightens the fibers in the form of thin web. This web is drawn through a funnel, which forms a rope-like structure called sliver.

c. **Spinning-** Treadle operated *Charkha* is used to prepare the hand spun blended arecanut yarn **(Fig. 1-3)** from the carded sliver and **Fig. 4** shows the manual fiber extraction process.

Fig.1-3 Processed Arecanut fiber

Fig. 1 Blended arecanut and cotton fiber (70:30)

Fig. 2 Carded sliver of blended arecanut fiber

Fig. 3 Hand spun arecanut and cotton blended yarn

Fig. 4 Textile fiber extraction from Arecanut husk by hand stripping method

The quality grades and uses of fibre are as follows-

- Grade-I finer Arecanut fiber blends with cotton fiber in 70 : 30 ratio for preparation of woven fabric
- Grade-II coarse Arecanut husk fibers for nonwoven and composite sheets only.
- On the basis of physicochemical properties, extracted fiber may be used for various purposes like filling in mattresses, or cushions of seats in automobiles, or

for blending with others fibers for further textile uses.

5. **Critical inputs/equipment/items required:** Arecanut agro waste husk, fiber processing machines (carding and spinning machine),
6. **Observation to be recorded:** fibre processing and spinning machine is needed.
7. **Target users/stakeholders:** KVKs/ Small Scale textile industries/ SHGs/ NGOs/ Handicraft Industries/ Handloom Weaving Centers
8. **Precaution(s) with the technology:**

- For better results use 70:30 blend for Grade-I finer Arecanut fiber blends with cotton fiber for preparation of woven fabric
- Grade-II coarse arecanut husk fibers is better used only for nonwoven and composite sheets.

9. **Advantage/ Benefits/ Utility of the technology:**

- Profitable utilization of a waste material thus facilitating environment protection.
- Additional source of income to the farm women by utilizing Arecanut husk waste.
- Awareness among farmers regarding the commercial importance of underutilized arecanut husk fiber for developing various value-added textile products.
- Source of income and capacity building for the SHGs and related enterprises for product diversification.
- Garo farmers generally discard Arecanut husk after nut extraction or use it for fuel purpose. This technology of product preparation from agro-biowaste is a significant contribution of Community Scientist under aegis of AICRP project.
- Farmers may open up their own enterprises or become successful supplier of arecanut textile fiber and yarn to textile industries as raw material for manufacturing of various textile structures.
- Farmers may use Arecanut husk fiber as growing bed for mushroom cultivation also.

10. **Economics of the technology/ Benefit: Cost Ratio:**

- Cost of fine fiber- Rs. 1000 kg^{-1}
- Cost of coarse fiber- Rs. 700 kg^{-1}
- Cost of blended yarn- Rs. 1200 kg^{-1}

11. **Technology developed under the project:**

AICRP (Home Science), ICAR-Central Institute for women in Agriculture: Project entitled "Comprehensive use of underutilized natural fibres and plant sources for sustainable livelihood of farm families (a) Fibre Based Research".

12. **Investigator(s)/inventor(s):**

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13. **Technology publication(s):**

Mishra, A. and Das, P. (2019). Underutilized Meghalyan Arecanut husk waste fiber for development of nonwoven textile material. *International Journal of Pure and Applied Bioscience*, **7**(2): 563-567.

Mishra, A. and Sangma, W. S. N. (2019). Fabrication of agro-waste Arecanut husk fiber, AICRP –TAD component, CCS, CAU, Tura, Meghalaya. (Printed Folders)

Mishra, A. and Sangma, W. S. N. (2019). Guebikop-onikoba·ratariani Fabrication of agro-waste Arecanut husk fiber, AICRP –TAD component, CCS, CAU, Tura, Meghalaya. (Folders in Garo- regional language).

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TECHNOLOGY:
NECTAR-PHT-127

1. **Name of the technology:** Woven handloom fabric from arecanut husk agro-waste
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2019
4. **Description of technology with salient features:**

Arecanut husk is an agricultural-by product or residue which may be used to develop eco-friendly textile materials as well as an income generating activity for farm women. Present technology envisages exploring the possibilities of utilizing plant biomass for fiber extraction and further textile applications. On the basis of these quality parameters, Arecanut textile material could be used for various technical textile applications *viz.* apparel manufacturing in clothtech and hometech, composites for various applications, mulching material in Agro-tech, as substitute of jute in Geo-textile, fillers and low buoyancy material in Automobile- textile, packaging, sanitary napkins and non -woven fabrics in medical textiles etc. Mainly two types of fibers are present – one very coarse (Grade-II) and the other very fine (Grade-I). The portions of the middle layer below the outermost layer are soft fibers, which are very similar to the jute fibers. New applications of agri waste fibers, like Arecanut husk fibers, will contribute to better management of agri-waste and facilitate sustainability.

Processing of fiber

Arecanut husk from mature fruits is collected and processed for fiber extraction. This outer husk is a rich source of cellulose that has potential use for textile applications. Urea and water retting method can be employed for extraction of fiber from the outer husk and fibers separated manually by hand stripping method. Various steps involved in extraction of fiber are detailed below:

a. **Pre-treatment and retting-** Arecanut husk is treated with 2% urea and steeped in water for 3 to 5 days.

b. **Mechanical extraction-**Treated husk is washed thoroughly with water and dried for 2-3 days. Thereafter, fibre from the husk can be separated manually by hand stripping method.

c. **Scouring-** Scouring of extracted fibre is carried out with 2.5% of NaOH, 1% Turkey red oil in MLR of 1:50 at 60 ^{0}C temperature for 30 mins.

d. **Bleaching-** Scoured fiber is bleached using 2% Hydrogen peroxide and 1.5% sodium silicate, 0.5% teepol and 1% turkey red oil in MLR of 1:50 at temperature 100ºC for 60 mins.

Preparation of yarn

As Arecanut fiber has lot of buoyancy and very soft hence it is difficult to process between carding rollers, hence it is blended with 30% cotton fibers for easy processing. Arecanut husk fiber has to undergo the sequential processes i.e. opening, carding and spinning to prepare the strong and uniform hand spun yarn and the processes are detailed below:

a. **Opening and blending-** The fibers are passed slowly in the opening machine, where the compact layer of fibers is

Fig. 1 Arecanut yarn and Union Handloom Fabric

Fig. 2 Backpack from Arecanut fabric

Fig. 3 Arecanut Waist coat

Fig. 4 Arecanut cotton blended handloom fabric

Fig. 5 Diversified products from agro waste Arecanut husk fibre

Figs. 1-5 Woven handloom fabric from agrowaste arecanut husk fiber

converted into light and fluffy tufts and foreign materials are removed from the fibers. Arecanut fiber is blended with cotton fiber for easy processing into 70:30 (Arecanut: cotton) ratio.

b. **Carding-** Carding machine is used which is composed of three cylinders. These cylinders are covered with the heavy fabric embedded with bent wires. The bent wire separates the fiber from the bundle, removes the vegetable matter from the fibers and straightens the fibers in the form of web. This web is drawn through a funnel, which forms a rope-like structure called sliver.

c. **Spinning-** Treadle operated *Charkha* is used to prepare the hand spun blended Arecanut yarn from the carded sliver.

Fabrication of arecanut husk fiber

Handloom fabric is woven on handloom by using Grade-I finer Arecanut fiber and cotton blended hand spun yarn and on the basis of physical performance can be used to prepare various household as well as apparel articles etc. **Arecanut woven handloom fabric** may further be utilized for various applications *viz.*, woven for making handloom fabric (household/apparel articles etc.

5. **Critical inputs/equipment/items required:** Arecanut agro-waste husk, fiber processing machines (carding and spinning machine), handloom,

6. **Observation to be recorded:** fiber processing machines (carding and spinning machine), handloom,

7. **Target users/stakeholders:** KVKs/ Small Scale textile industries/SHGs/ NGOs/Handicraft Industries/ Handloom Weaving Centers.

8. **Precaution(s) with the technology:**

- For better results use 70:30 blend of Grade-I finer Arecanut fiber with cotton fiber for preparation of woven fabric

9. **Advantage/ Benefits/ Utility of the technology:**

- Awareness among farmers regarding the commercial importance of underutilized arecanut husk fiber for developing various value-added textile products.
- Source of income and capacity building for the SHGs and related enterprises for product diversification.

10. **Economics of the technology/ Benefit: Cost Ratio:** Woven material- Rs. 200 m^{-1} (Comparable to other handloom woven fabric)

11. **Technology developed under the project:**

AICRP (Home Science), ICAR-Central Institute for women in Agriculture: Project entitled "Comprehensive use of underutilized natural fibres and plant sources for sustainable livelihood of farm families (a) Fibre Based Research".

12. **Investigator(s)/inventor(s):** Anupama Mishra; Email: anupamamishra8@gmail.com; Mobile: 9997541341

13. **Technology publication(s):**

Mishra, A. and Das, P. (2019). Underutilized Meghalyan Arecanut husk waste fiber for development of nonwoven textile material. *International Journal of Pure and Applied Bioscience*, **7**(2): 563-567.

Mishra, A. and Sangma, W. S. N. (2019). Fabrication of agro-waste Arecanut husk fiber, AICRP –TAD component, CCS, CAU, Tura, Meghalaya. (Printed Folders)

Mishra, A. and Sangma, W. S. N. (2019). Guebikop-onikoba·ratariani Fabrication of agro-waste Arecanut husk fiber, AICRP –TAD component, CCS, CAU, Tura, Meghalaya. (Folders in Garo- regional language).

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TECHNOLOGY:
NECTAR-PHT-128

1. **Name of the technology:** Nonwoven material from agro-waste arecanut husk
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2019
4. **Description of technology with salient features:**

Present technology on developing nonwoven samples from *Areca Catechu* fibers introduces a new functionality to the Meghalayan agri-waste *Areca Catechu* husk fibers. This study also paved way to sustainability as the waste has been utilized to produce a valuable textile product. About 50 percent of the recovered arecanut husk is finer while the rest is coarse in texture. The tenacity value of Arecanut husk fibre is comparable to that of goat hair and woollenised jute. On the basis of quality parameters tested, this needle punched Arecanut nonwoven material could be used for various technical textile applications viz. mulching material in Agro-tech, as substitute of jute in Geo-textile, fillers and low buoyancy material in Automobile- textile, packaging, sanitary napkins and nonwoven fabrics in medical textiles etc.

Collection of Fiber

Arecanut husk is obtained from fruits harvested at full maturity. The epidermis of the fruit is generally thrown out which forms agro waste or been used as a material for burning. This outer husk is a rich source of cellulose that has been used for nonwoven textile materials.

a. **Pre-treatment and retting-** Arecanut husk is treated with 2% urea and steeped in water for 3 to 5 days.

b. **Mechanical extraction-**Treated husk is washed thoroughly with water and dried for 2-3 days. Thereafter, fibre from the husk can be separated manually by hand stripping method.

c. **Scouring-** Scouring of extracted fibre is carried out with 2.5% of NaOH, 1% Turkey red oil in MLR of 1:50 at 60^0C temperature for 30 mins.

d. **Bleaching-** Scoured fiber is bleached using 2% Hydrogen peroxide and 1.5% sodium silicate, 0.5% teepol and 1% turkey red oil in MLR of 1:50 at temperature 100ºC for 60 mins.

Web formation, web feeding and needle punching

Nonwoven material was prepared from extracted coarser or II- grade Arecanut husk fibers using needle punching method. Web was formed by placing two web layers i.e. first layer was placed in longitudinal direction then second layer was placed in crosswise direction. Arecanut husk fibers web was delivered to needle punching machine by means of web feeder. The web feeder prevented the layered web to get deformed. In needle punching machine, 3.5-inch barbed needles were used for the preparation of non-woven fabric. The barbed needles having gauge 32 and the punch density was kept 105 cm^{-2}. The speed of needle punching was 2 m min^{-1}. The penetration of the needle in the web was 1.2 cm. As far as utility is concerned nonwoven material may be suitable for the preparation of handicrafts

items, doormats, rugs and floor coverings and sanitary napkins etc. etc. Arecanut nonwoven materials may further be utilized for various applications *viz*., woven for making handloom fabric (household/apparel articles), nonwoven for small area rugs/carpets/doormats and sanitary napkins etc.

Fig. 1 Arecanut fiber

Fig. 2 Needle punched NonwovenaArecanut material

Critical inputs/ equipment/ items required: Arecanut agro- waste husk, needle punching machine

6. **Observation to be recorded:** Needle punching machine

7. **Target users/stakeholders:** KVKs/ Small Scale textile industries/SHGs/ NGOs/Handicraft Industries/ Handloom Weaving Centers

8. **Precaution(s) with the technology:**

- Grade-II coarse arecanut husk fibers is better used only for nonwoven material.
- On the basis of physicochemical properties, prepared arecanut nonwoven may further be utilized for various applications *viz*., for nonwoven for small area rugs/carpets/ doormats, packaging and sanitary napkins etc.

9. **Advantage/Benefits/Utility of the technology:**

- Developed Arecanut nonwoven material is both environment and farmer-friendly and also, the product made out of the husk is eco-friendly and contains no chemicals.
- Profitable utilization of a waste material thus facilitating environment protection and additional source of income to the farm women by utilizing Arecanut husk waste.
- Awareness among farmers regarding the commercial importance of underutilized arecanut husk fiber for developing various value-added textile products.
- Source of income and capacity building for the SHGs and related enterprises for product diversification.
- Garo farmers generally discard Arecanut husk after nut extraction or use it for fuel purpose. This technology of product preparation from agro-biowaste is a significant contribution of Community Scientist under aegis of AICRP project.

10. **Economics of the technology/ Benefit: Cost Ratio:**

Nonwoven material- Rs. 60 m^{-2}

11. **Technology developed under the project:**

AICRP (Home Science), ICAR-Central Institute for women in Agriculture: Project entitled "Comprehensive use of underutilized natural fibres and plant sources for sustainable

livelihood of farm families (a) Fibre Based Research".

12. **Investigator(s)/inventor(s):** Anupama Mishra; Email: anupamamishra8@gmail.com; Mobile: 9997541341.

13. **Technology publication(s):**

Mishra, A. and Das, P. (2019). Underutilized Meghalyan Arecanut husk waste fiber for development of nonwoven textile material. *International Journal of Pure and Applied Bioscience*. **7**(2): 563-567.

Mishra, A. and Sangma, W. S. N. (2019). Fabrication of agro-waste Arecanut husk fiber, AICRP – TAD component, CCS, CAU, Tura, Meghalaya. (Printed Folders).

Mishra, A. and Sangma, W. S. N. (2019). Guebikop-onikoba·ratariani Fabrication of agro-waste Arecanut husk fiber, AICRP –TAD component, CCS, CAU, Tura, Meghalaya. (Folders in Garo- regional language).

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TECHNOLOGY:
NECTAR-PHT-129

1. **Name of the technology:** Composite material from areca nut husk agro-waste
2. **Source of the technology:** CCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2019
4. **Description of technology with salient features:**

Agro-waste material utilization in Meghalaya is an important means to conserve the environment from dumping large quantity in to bare lands and it also helps in new innovative product development from no cost materials. Arecanut fiber belongs to the species *Areca Catechu Linnaeus* under the family *Palmacea*. Among all the natural fibers Arecanut fiber, a type of nut shell fibers, is more promising because it is inexpensive, derived from very high potential perennial crop and abundantly available in Garo hills of Meghalaya but has limited applications. In the present technology dried well matured *Areca catechu* fruits were collected in large quantities and the fiber was extracted by hand stripping method. This fiber was given alkali pre-treatment, scoured and then processed for preparation of composites.

Mould preparation

Arecanut husk fibers were chopped into small particles i.e. around 10mm for further preparation of composites. It was decided to prepare composites sheets using chopped arecanut husk fibers in 25:75 weight ratios with PVA resins respectively.

The composite sheets were prepared with composites mixtures of reinforced arecanut husk fibers, resin and cross-linking agent. PVA matrix, H_2SO_4 (cross linking agent) and arecanust husk fibers were mixed with glass rod and care should be taken to avoid formation of bubbles because the air bubbles may result failure in the material. Polyvinyl alcohol (PVA) resin is a synthetic polymer which was used in composite material by adding 5% PVA (10 g PVA dissolve with 200 ml distilled water). Cross linking was done to make the film insoluble in water by adding 2 ml H_2SO_4 solution. Further this mixed solution was stir using magnetic stirrer and heated at temperature 95°C for 2 hours. Arecanut husk fiber was then added to solution in 25% for preparing composites sheets. This prepared composite mixture was now ready to pour into molding tray. The molding tray was prepared using a fiber glass sheet having the dimensions of 25 cm x 25 cm. Surface impurities like dirt/dust present on molding tray was removed by cleaning tray with acetone. The greasing or releasing agent i.e. silica gel was applied on its surface for easy removal of the casting and finally the mould was ready to cast composite mixtures.

Coloured composite sheets were also prepared by adding dye (a pinch of dye dissolved in required amount of water) solution in composites mixture and stirrer for 10 minutes for proper mixing. Prepared composites mixture was finally poured into mould for further process of making composites.

Casting

The molding tray having composites mixture was further dried in a vacuum oven at 80°C for approximately 24 hours to convert viscose composites mixture into sheets form. Oven dried composite sheet was further hot pressed in a Compression Molding Machine at 80°C

temperature for 2 h at 0.98 MP pressure so that fibers were properly settled down in oven dried composites sheets.

Tensile strength (26.225 MPa) and elongation percent (15.16%) was observed for prepared 2 mm composite sheets. prepared arecanut husk fiber composites sheets were converted into nursery grow composites bag with heat setting bag making machines.

Casted composite sheets are flexible *i.e.* they can be molded and heat set in different shapes. The colour of the fibers was also change after casting. It turns into light brown color from dark brown colour. coloured sheet was used for preparation of arecanut husk nursery grow bag for agriculture application. Nursery grow bag has same appearance as of already available plastic plant grow bags in market. But these products are completely biodegradable and ecofriendly as prepared from green composites. Another point is that these products have a unique texture as arecanut husk fibers are embedded in transparent sheet or polythene like structure due to using PVA matrix. Its best utilization of waste arecanut husk fiber as reinforced material in combination of biodegradable PVA matrix. Besides these applications this prepared arecanut husk fiber composites sheet may be use in other areas also as covering sheet in green house i.e.in agro-tech, table mats, mulching mats, layering sheet in auto mobiles, as surgery garbage disposal bags and in sport articles and packaging of fruits and vegetables etc.

Fig. 1 Arecanut fiber

Fig. 2 Composite mixture pouring in moulding tray

Fig. 3 Arecanut nursery grow bag from Composite sheet

5. **Critical inputs/equipment/items required:** Arecanut agro-waste husk, PVA resins, H_2SO_4 (cross linking agent) for composites, hot air oven for casting

6. **Observation to be recorded:** NA

7. **Target users/stakeholders:** KVKs/ Small Scale textile industries/ SHGs/ NGOs/ Packaging industries

8. **Precaution(s) with the technology:** Grade-II coarse arecanut husk fibers is better used for composite sheets.

9. **Advantage/ Benefits/ Utility of the technology:**

- Composites material can be developed using PVA matrix reinforced with arecanut husk fibers for further preparation of biodegradable mulching sheets, nursery grow bags and packaging materials etc.
- Awareness among farmers regarding the commercial importance of underutilized arecanut husk fiber.
- Garo farmers generally used to discard arecanut husk fibers after nut extraction or for fuel purpose. This technology of product preparation from agro-biowaste is a significant contribution of Community Scientist under aegis of AICRP project. Further it makes them aware to utilize this biowaste for alternate use in textile field.

- Garo farmers generally discard arecanut husk after nut extraction or use it for fuel purpose. This technology of product preparation from agro-biowaste is a significant contribution of Community Scientist under aegis of AICRP project.

10. Economics of the technology/ Benefit: Cost Ratio: Composites material- Rs. 40 m^{-2}

10. Technology developed under the project:

AICRP (Home Science), ICAR-Central Institute for women in Agriculture: Project entitled "Comprehensive use of underutilized natural fibres and plant sources for sustainable livelihood of farm families (a) Fibre Based Research".

11. Investigator(s)/inventor(s): Anupama Mishra; Email: anupamamishra8@gmail.com; Mobile: 9997541341.

12. Technology publication(s):

Mishra, A. and Das, P. (2019). Underutilized Meghalyan arecanut husk waste fiber for development of nonwoven textile material. *International Journal of Pure and Applied Bioscience*. **7**(2): 563-567.

Mishra, A. and Sangma, W. S. N. (2019). Fabrication of agro-waste Arecanut husk fiber, AICRP –TAD component, CCS, CAU, Tura, Meghalaya. (Printed Folders)

Mishra, A. and Sangma, W. S. N. (2019). Guebikop-onikoba·ratariani Fabrication of agro-waste arecanut husk fiber, AICRP –TAD component, CCS, CAU, Tura, Meghalaya. (Folders in Garo- regional language).

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TECHNOLOGY:
NECTAR-PHT-130

1. **Name of the technology:** Antimicrobial finish and herbal dyeing from arecanut extract
2. **Source of the technology:** CoCSc (CAU, Imphal), Tura, Meghalaya
3. **Year of adoption/development:** 2019
4. **Description of technology with salient features:**

Antimicrobial finish and herbal dyeing using arecanut extract in simultaneous bath is the technological invention of this study for development of functional finishes for textiles. Arecanut is commonly found in Garo hills of Meghalaya and known for its medicinal value having high TPC (Total phenolic content) and significant antimicrobial activity. Plant phenols represent one of the major groups of bioactive compounds acting as primary antioxidants or free radical terminators. Total phenolic content of arecanut ethanol extract is determined *i.e.,* 163.07±0.16 GAE mg g^{-1}. Antibacterial activity of nut extracts (ethanolic) against *Staphylococcus aureus* and *Escherichia coli* was assessed and it was observed that among the bacterial species, comparatively higher inhibition zone was observed against Gram positive (*Staphylococcus aureus*) bacteria than Gram negative (*Escherichia coli*) bacteria. Minimum Inhibitory Concentration (MIC) of Arecanut against *Staphylococcus aureus* is recorded to be 50% and against *E. coli* is 60%. High TPC and good antimicrobial activity indicates potential use of extract for functional finishes.

Use of the inherent antimicrobial properties found in certain plants extracts is a viable option for the textile finishing industry for functional textile applications. Arecanut extracts showed good antimicrobial activity which indicates that these extracts may be useful for imparting antimicrobial textile finishes for treatment of various types of skin/wound infections and medical textile applications. Arecanut contains active substances such as alkaloids, tannins etc., produced during their secondary metabolism, which impart medicinal properties. Arecanut extract can be used in colouring as well as for imparting antimicrobial finish in a single bath for diversified functional use.

Single bath treatment for multifunctional performances:

Arecanut extract is used for natural herbal dyeing as well as imparting antimicrobial finishes to garment in single bath. Tannin rich nuts are dried and crushed into powder immediately after dehusking and used as source of natural colorant having antimicrobial finish. Various shades can be obtained through mordanting with chemical as well as natural mordants.

Antimicrobial finishing of textile material

The pretreated cotton fabrics were immersed in the antimicrobial stock solution containing arecanut powder (10% w v^{-1}), cross linking agents (6% citric acid owf) for one hour and shade dried.

Wash durability of finished fabric

Dyed samples can be assessed for colour fastness to washing, sunlight, perspiration and rubbing. A key issue to be considered in any finishing treatment is the durability of the finish. The treated fabric samples are subjected to five, ten and fifteen wash cycles using neutral liquid soap (5 g pl) for ten minutes, keeping the material to liquor ratio at 1:30 and shade dried. The washed fabrics are later assessed for the retention of antibacterial activity against *Staphylococcus aureus* and *Escherichia coli* as per AATCC 147 standards after each subsequent wash. The antibacterial activity is assessed by measuring the zone of inhibition. Fabrics treated with

arecanut herbal extracts showed antibacterial activity against both *Staphylococcus aureus* and *E. coli*. Corresponding zone produced by arecanut extract for *S. aureus* and *E. coli* are 6.5 mm and 4.5 mm, respectively. Comparatively higher inhibition zone is observed against Gram positive (*Staphylococcus aureus*) bacteria than Gram negative (*Escherichia coli*) bacteria. Results confirmed that antimicrobial activity of arecanut treated cotton fabric diminished gradually as the number of wash frequencies increases. Antimicrobial activity against *S. aureus is* retained even after 15 wash cycles that means the samples can fight against microorganism even after ten to fifteen washes.

This kind of eco-treated herbal clothing or fabric products having antimicrobial properties can be used as medical textiles for cure of skin related diseases and wound healing bandages etc. Commercialization of such multi-functional natural extracts can be a successful venture for rural population of the state and through systematic and scientific extraction, purification; chemical characterization and promotion of use of herbal extract it has potential to enhance local economy.

Antimicrobial property: Standard wash durability test was conducted with antimicrobial assessment test on each successive wash for checking durability or shelf life of textile finishes. It was found that antimicrobial finish retains up to 15 wash. This is renewable antimicrobial finish and herbal dyeing with areca nut extract. Though joint pain-relieving bandages may be further renewed after certain wash cycle for effective use however wound bandages are of one time use only so one-time treatment is required. Sports clothing, medical gowns and other clothing can be renewed after every 15 wash with areca nut herbal extract for preventing chances of contamination with any infectious disease. Antimicrobial finish and

1. Natural dyeing with Arecanut herbal extract

2. Antimicrobial finish and dyeing with nut extracts

3. Antimicrobial assessment of fabric samples treated with Arecanut herbal extract for wash durability

Fig. 4 Medical bandages ecotreated with renewable antimicrobial finish from Areca nut herbal extract

Fig. 5 Sports T-shirt finished with renewable antimicrobial finish from Areca nut herbal extract

Fig. 1-5 Natural dyeing and antimicrobial finish from arecanut herbal extract

herbal dyeing from arecanut extract.

5. **Critical inputs equipment/items required:** Areca nut extracts, sodium hydroxide, citric acid for cross linking, chemical or natural mordants for different shades, dyeing vessel and heating apparatus.

6. **Target users/stakeholders:**

   MTTCs/KVKs/Small Scale dyeing house and textile finishing industries/ SHGs/ NGOs /handloom weavers

7. **Precaution(s) with the technology:**

- Maintain temperature and dyeing time for better affinity with textile material.
- Imparted finish diminishes gradually as wash frequencies increase.
- It is renewable finish therefore for better functionality renew or reapply arecanut extract finish after 15 wash as antimicrobial property decreased with increasing number of wash cycles.

8. **Advantage/Benefits/Utility of the technology:**

- Sensitization of rural people regarding medicinal values of locally available plant extracts on clothing and other uses.
- Standardized protocol for eco-friendly processing of arecanut for multifunctional use in textile.
- Awareness among farm women regarding commercial importance of such locally available plant sources.
- Eco-friendly herbal curative renewable finish from locally available medicinal plant extracts for green minded consumers.
- Technological intervention for this finish is multifunctional performance in single bath treatment.
- Antimicrobial finish gadgets can find use in medical textile and other related applications. Various clothing and medical gadgets *viz*., Sports T-shirts, wound bandages; knee joint pain bandages may be eco-treated with arecanut extract imparting antimicrobial finish.

9. **Economics of the technology/ Benefit: Cost Ratio:** Total cost involved in antimicrobial finish application- Rs. 30 m^{-1}

10. **Technology developed under the project:**

    AICRP (Home Science), ICAR-Central Institute for Women in Agriculture: Project entitled "Comprehensive use of underutilized natural fibers and plant sources for sustainable livelihood of farm families (a) Functional Finish Based Research"

11. **Investigator(s)/inventor(s):** Anupama Mishra, Email: anupamamishra8@gmail.com; Mobile: 9997541341

12. **Technology publication(s):**

Mishra, A. and Sangma, W. S. N. (2019). Herbal Dyeing and antimicrobial finish from Aarecanut extracts, AICRP –TAD component. Pub: CCS, CAU, Tura, Meghalaya. (Printed folder)

Mishra, A. and Sangma, W. S. N. (2019). Gue bite oniko rong dim·na ba jo·ongrangko champenganiko bikotani, AICRP –TAD component. Pub: CCS, CAU, Tura, Meghalaya. (Folder in Garo- regional language)

Mishra, A., Sangma, W. S. N. and Das, P. (2019). Value added Eco- finish from Arecanut dye for diversified textile applications. National seminar on "Role of Community Science Education in Rural Development" Organized by College of Home Science, G. B. P. U. A. & T., Pantnagar, Uttarakhand, 21-22 August, 2019. p. 64. (Abstract and Full Paper).

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TECHNOLOGY:
NECTAR-PHT-131

1. **Name of the technology:** Modified *Vawksa rep* ; a smoked pork product
2. **Source of the technology:** CVSc&AH (CAU, Imphal), Aizawl, Mizoram
3. **Year of adoption/ development:** 2020
4. **Description of technology with salient features:**

'Sa-rep' which means smoked meat (*Sa*-is meat, and *rep* means dehydrated or dry in Mizo language) is locally prepared in Mizoram and popularly consumed and preferred by majority of the Mizo people. *Vawksa rep*, the smoked pork product, is one of the most favourite and popular products of Mizoram. It is prepared by light smoking (2-3 hours) of pork chunks of almost uniform size.

The problem associated with *Vawksa rep* is that it has a short shelf life, as no other treatment is applied to the meat except light smoking and the big fat pieces attached with the meat product is prone to rancidity. Moreover, the product in the market is sold without proper packaging and not at all aesthetically pleasing to eyes.

The traditional pork product of Mizoram, *Vawksa rep* was modified by exploring the possibility of curing in combination with application of *Nisin* and proper packaging in order to derive preservative effect in extending the durability of *Vawksa rep*. It is prepared with slight modification of the traditional *Vawksa rep*. Pork meat are cut into small pieces of almost uniform size (3x3 in.) Pork chunks, which are to be cut into uniform size (3 x 3 in.) with a knife, are cured for 24 h.

The meat chunks are subsequently placed in the smoke unit (KerresShowsmoker CS 350 EL) and then smoked for 45 minutes. Hardwood saw dust is used for smoking the meat. After smoking and before packaging, the product should be sprayed with *Nisin* (Hi-Media Laboratories Pvt. Ltd.) with the help of a sprayer at the rate of 5 mg kg^{-1} of product. Vacuum packaging was found to be better compared to aerobic packaging of both Traditional and Modified *Vawksa rep* kept under refrigerated storage for 15 days, as all the physicochemical, microbiological and sensory properties of the products were found to be superior in case of vacuum packaged samples.

By curing and applying *Nisin*, a new product, the modified form of *Vawksa rep* could be developed successfully with superior physicochemical, microbiological and sensory properties. The modified *Vawksa rep* enjoyed superior sensory rates throughout the storage period and found to be highly acceptable even on 15th day of storage whereas gradual decrease in the sensory scores of Traditional *Vawksa rep* was observed and was found to be almost unacceptable at 15th day of storage.

Modified *Vawksa rep* may prove to be a good source of profit to the local farmers/ producers as it can be produced by using simple technology and comparable cost of production (almost similar) with traditional *Vawksa rep*, but with superior product qualities.

5. **Critical inputs required:**

- Pork meat
- Curing ingredients
- Spices
- Nisin
- Packaging material.

Fig. 1 Traditional *vs* Modified *Vawksa rep*

Fig. 2 Preparation of modified *Vawksa rep*

Fig. 3 Preparation of modified *Vawksa rep*

6. Observation to be recorded:

- Sensory acceptability
- Reduce or absent of spoilage indicators
- Permissible microbial level
- Improvement in appearance.

7. Target users/stakeholders:

Multi Technology Testing Centers (MTTCs)/ KVKs/ Entrepreneurs and Farmers

8. Precaution (s) with the technology:

Additives to be added very carefully as per the recommended levels, curing time, smoking time and the packaging should be maintained as per the recommended procedure.

9. Advantage/ Benefits/ Utility of technology:

Can be adopted by the entrepreneurs as well as the farmers for better quality ethnic products.

10. Economics of the technology/ Benefit: Cost Ratio:

With this technology without investing much input more profit may be obtained as the demand is definitely expected to be more with increasing sensory quality and shelf life.

11. Technology developed under the project: Student's PG Research work.

12. Investigator(s)/inventor(s):

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13. Technology publication(s):

MVSc Thesis submitted to the CAU, Imphal.

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TECHNOLOGY:
NECTAR-PHT-132

1. **Name of the technology:** Low cost Smoked Chicken sausages incorporated with bamboo shoot
2. **Source of the technology:** CVSc&AH (CAU, Imphal), Aizawl, Mizoram
3. **Year of adoption/development:** 2020
4. **Description of technology with salient features:**

   Globally, there is an increasing demand for food with both nutritional and functional health benefits and preferably it should be low in cost. Comminated meat products provide an attractive pathway for utilization of low value cuts, edible offal as well as other health beneficial plant-based ingredients by replacing the meat to some extent to reduce their cost of production. Bamboo shoots can be successfully incorporated for nutritional improvement as well as from economical point of view and also to give a preservative effect. Bamboo shoots may be soaked overnight and cooked and chopped before adding to the sausage mix. In a formulation, 8% of meat can easily be replaced with bamboo shoots without effecting the sensory attributes as well as other nutritional quality. By adding bamboo shoot an ethnic taste may be given to the products while incorporating the beneficial dietary fibre in the product. Moreover, bamboo shoots are easily available in the North Eastern part of India and is available perennially. The entrepreneurs and meat processors can effectively use the low value cuts of chicken along with bamboo shoot to obtain the maximum return by utilizing low-cost but nutrient rich commodities. The **Fig. 1-3** shows the preparation of low cost chicken sausage incorporated with bamboo shoots.

Fig. 1 to 3 Preparation of low-cost chicken sausages incorporated with bamboo shoots

5. **Critical inputs required:**

- Chicken meat
- Curing ingredients
- Spices
- Bamboo shoot
- Packaging material

6. **Observations to be recorded:**

- Sensory acceptability
- Reduce or absent of spoilage indicators

• Permissible microbial level	• Improvement in appearance.

7. **Target users/stakeholders:**

   MTTCs/ KVKs/Entrepreneurs/Farmers

8. **Precaution(s) with the technology:**

   Additives to be added very carefully as per the recommended levels, curing time, smoking time and the packaging should be maintained as per the recommended procedure.

9. **Advantage/Benefits/Utility of the technology:**

   Can be adopted by the entrepreneurs as well as the farmers for better quality ethnic products.

10. **Economics of the technology/ Benefit: Cost Ratio:**

    With this technology without investing much input more profit may be obtained as the demand is definitely expected to be more with increasing sensory quality and shelf life.

11. **Technology developed under the project:** Student's PG Research work.

12. **Investigator(s)/inventor(s):**

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13. **Technology publication :**

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TECHNOLOGY:
NECTAR-PHT-133

1. **Name of the technology:** Technology for preparation of functional chicken nuggets and patties with French bean and chickpea flour
2. **Source of the technology:** CVSc& AH (CAU, Imphal), Selesih, Aizawl, Mizoram
3. **Year of adoption/ development: 2020**
4. **Description of technology with salient features:**

Meat and meat products supply a large number of nutrients (protein, fat, vitamins and minerals) to the diet. Meat is a fundamental source of proteins of high biological value. It is a well-balanced sources of amino acids those satisfies human physiological requirements. But nowadays, situations are prompting the development of new and "healthier" meat products, prominent among them are the functional foods. Functional meat derivatives present an excellent opportunity to diversify food products portfolio of emerging market. Meat and meat products are low in fibre hence, incorporation of vegetables or flours in meat products can be a solution, as it will positively increase the fibre content of the product and these types of products can be designed to be less calorifically dense while remaining more satiating and tasty. The attributes of vegetables and flours include high fibre, low fat and low energy density.

Spent hens can be used for developing functional chicken nuggets by incorporating high quality vegetable fibres using French bean and chickpea flour. The meat, by-products (skin, gizzard and heart), French bean and Chickpea flour and other additives (condiment mixture, spice etc.) can be utilized to a great extent to develop a highly desirable value-added chicken product. The beans need to be finely chopped and added to the meat emulsion and mixed properly before making the products. Flour is to be added to the meat emulsion in the bowl chopper in the last part of emulsion making.

5. **Critical inputs required:**

- Spent hen meat
- French bean incorporation level
- Additives
- Chickpea flour incorporation level
- Cooking time
- Storage temperature
- Packaging method

6. **Observation to be recorded:**

- Sensory acceptability
- Reduce or absent of spoilage indicators
- Permissible microbial level
- Improvement in appearance
- Proximate composition

7. **Target users / stakeholders:** Entrepreneurs and Farmers

8. **Precaution (s) with the technology:** Additives to be added very carefully as per the recommended levels, chopping time, cooking time and the packaging should be maintained as per the recommended procedure.

9. **Advantage/ Benefits/ Utility of technology:** Can be adopted by the entrepreneurs as well as the farmers for better quality ethnic products.

10. **Economics of the technology/Benefit: Cost Ratio:** With this technology without investing much input more profit may be obtained as the demand is definitely expected to be more with increasing sensory quality and shelf life.

11. **Technology developed under the project:** Intramural Research Project.

12. **Investigator(s)/inventor(s):**

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13. **Technology publication(s):**

    M.V.Sc Thesis submited to the CAU (Imphal).

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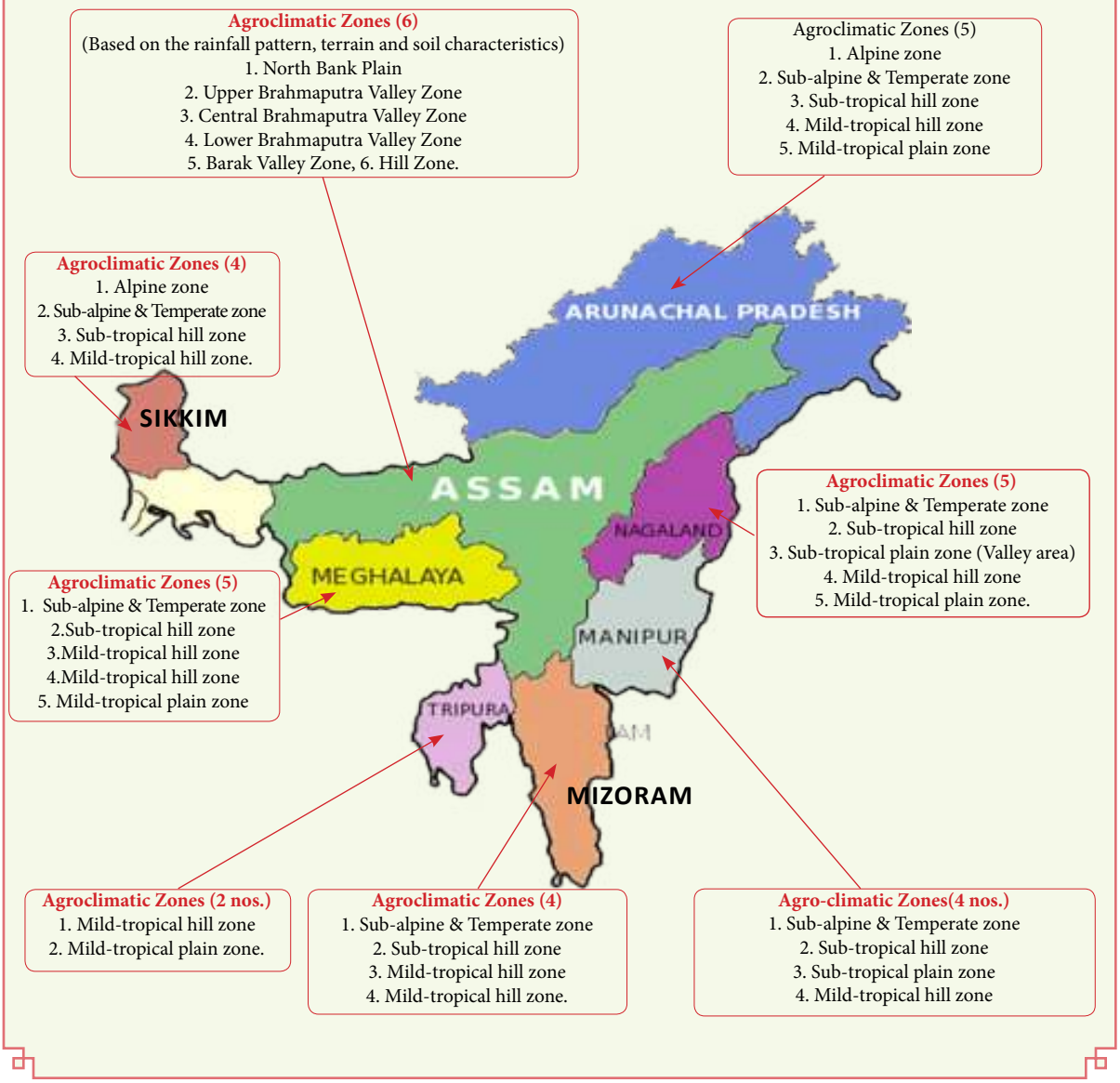
AGROCLIMATIC ZONES OF NORTH EAST REGION OF INDIA



LIST OF CROPS OF NEH REGION

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ARUNACHAL PRADESH

CROPS

1. **Temperate zone** (Tawang, Dirang, Bomdila, Shergaon, Upper Subansiri, Anini, North eastern part of Lohit and Northern part of East Siang)

   Rice, maize, buckwheat, millets, black gram, green gram andarhar

   Cabbage, cauliflower, knol-khol, broccoli, radish, turnip, beetroot, carrot, garlic, onion, spinach, cucumber, tomato, brinjal, okra, French bean, asperagus, bean, capsicum and peas

   Apple, pear, peaches, plums, cherries, pistachio, almond, apricot, walnut, chestnut, kiwi fruit and pecan nut.

2. **Subtropical zone** (Changlamg, Khonsa, areas of Tirap district, Basar area of Siang district): Rice, maize, buckwheat, millets, black gram, green gram & arhar. Brinjal, tomato, okra, beans (broad, rajma, bush and pole French bean), peas, carrot, radish, turnip, cole crops, leafy vegetables (palak, methi, mustard), onion, garlic, chili and capsicum, potato, sweet potato, colocasia, yams, alocasia and chow chow.

   Mango, guava, citrus, Mandarin orange, litchi, low chilling peaches, pears, plums, almond, aonla.

   Rose, gladiolus, orchids, carnation, chrysanthemum, marigold, petunia, large number of other ornamental and foliage plants.

3. **Tropical zone** (Southern part of lower Subansiri, Pasighat, and lower part of Lohit) Rice, maize, buckwheat, millets, black gram, green gram & arhar. Brinjal, tomato, okra, beans (broad, bush, climbing), gourds (bottle, ridge, ash, bitter), cowpea, amaranthus,pumpkin, mustard.

   Cassava, sweet potato, amorphophallus, dioscorea, yams, coleus, colocasia, tree bean. Mango, citrus, Assam lemon, banana, pineapple, papaya, grapes, sapota, passion fruit, water melon, snape melon.

   Coconut, arecanut, cashew, oil palm, rubber, cocoa, tea, tree tomato, coffee and cinnamom Turmeric, ginger, large cardamom, pepper. Rose, chrysanthemum, jasmine, marigold, balsum, orchids, Tube rose,Gerbera, Anthurium.

LIVESTOCK

Piggery, Poultry, Duckery, Goatery, Dairy, Mithun

FISHERIES

1. **Temperate zone:** Trout farming; Composite fish culture with 3 species (silver carp, grass carp, common carp); Integrated Farming System: Fish-Pig-Veg, Fish (common carp)-Paddy.
2. **Subtropical zone:** Composite fish culture with 3 species (silver carp, grass carp, common carp); Integrated Farming System: Fish-Pig-Veg, Fish-Paddy.
3. **Tropical zone:** Composite fish culture with 6 species (catla, rohu, mrigal, silver carp, grass carp, common carp); Integrated Farming System: Fish-Pig-Veg, Fish-Paddy.

Note: Location specific / season specific crops to be selected

ASSAM

CROPS

Tropical zone (except North Cachar and KarbiAnglong districts)

Rice, maize,black gram, green gram, arhar, cowpea, French bean, pea, sugarcane, cotton. jute Brinjal, tomato, beans (broad, rajma, climbing), peas, carrot, radish, cabbage, cauliflower, onion, garlic, chili, capsicum, amaranthus, pumpkin, cucumber, gourds (bottle, ridge, ash, bitter), okra,corn, leafy vegetables (palak, methi, mustard).

Potato, sweet potato, amorphophallus, colocasia, elephant foo yam (Oal), alocasia.

Mango, jackfruit, guava, oranges, almond, walnut, citrus, lemon, Assam lemon, banana, litchi, pineapple, papaya, avocado and other fruits.

Turmeric, ginger, cardamom, cinnamon, cloves, betel nut, chili pepper, coriander, garlic, onion, etc. Tea, arecanut, coconut, cashew, coffee, cinaamom, black pepper.

Rubber, bamboo, teak Rose, gladiolus, orchids, carnation, chrysanthemum, marigold, petunia, jasmine, gerberabalsum, large number of other ornamental and foliage plants.

LIVESTOCK

Poultry, Piggery, Duckery, Goatary, Dairy

FISHERIES

Composite fish culture with 6 species (catla, rohu, mrigal, silver carp grass carp, common carp,); Integrated Farming System: Fish-Pig-Veg etc.

Note: Location specific / season specific crops to be selected

MANIPUR

CROPS

1. **Subtropical zone**

   Rice, maize,buckwheat, millets,black gram, green gram&arhar.

   Brinjal, tomato, okra, beans (broad, rajma, bush and pole French bean), gourds (bottle, ridge, ash, bitter), peas, carrot, radish, turnip, vegetables (palak, methi, mustard), cabbage, cauliflower, broccoli, onion, garlic, chili, king chili, capsicum and makhana.

   Potato, sweet potato, colocasia, yams, allocasia, chow-chow, Chinese chives.

   Mango, guava, citrus, litchi, low chilling peaches, pears, plums, almond, aonla, ber, Mandarin orange and passion fruit.

   Rose, gladiolus, orchids, carnation, chrysanthemum, marigold, petunia, large number of other ornamental and foliage plants.

2. **Tropical zone**

   Rice, maize,buckwheat, millets,black gram, green gram, arhar.

   Brinjal, tomato, okra, beans (broad, rajma, bush and pole French bean), gourds (bottle, ridge, ash, bitter), coriander, cowpea, amaranthus, pumpkin, chilli, King chili, mustard, cucumber, colacasia, cowpea etc.

Cassava, sweet potato, amorphophallus, dioscorea, yam, allocasia.

Turmeric, ginger large cardamom, pepper etc.

Tree bean, coconut, arecanut, cashew, oil palm, rubber, cocoa, tea, coffee, cinnamom.

Mango, citrus, banana, pineapple, papaya, grapes, sapota, dragon fruit, ber, aonla.

Rose, chrysanthemum, jasmine, marigold, gerbera,balsum, orchids etc.

LIVESTOCK

Piggery, Poultry, Duckery, Goatery, Dairy

FISHERIES

Composite fish culture with 6 species (catla, rohu, mrigal, silver carp, grass carp, common carp) and indigenous carps (Pengba, Natun etc.); Integrated Farming System: Fish-Pig-Veg etc.

Note: Location specific / season specific crops to be selected

MEGHALAYA

CROPS

1. **Temperate zone** (Upper Shillong, Mawphlong and Mairang):

   Rice, maize,green gram, black gram, arhar.

   Cabbage, cauliflower, knol-khol, broccoli, radish, turnip, beetroot, carrot, garlic, onion, spinach, cucumber, tomato, brinjal, okra, French bean, bean, capsicum and peas.

   Apple, pear, peache, plum, cherry, pistachio, almond, apricot, walnut, chestnut and kiwi fruit.

2. **Subtropical zone** (Jawai, Nongstonin, Nokrek, Kailash area of west garo hills, western part of east garo hills and Umkeang area):

   Rice, maize,green gram, black gram, arhar.

   Brinjal, tomato, okra, beans (broad, rajma, bush and pole French bean), gourds (bottle, ridge, ash, bitter), peas, carrot, radish, turnip, cole crops, vegetables (palak, methi, mustard), onion, garlic, chili, King chili, mustard and capsicum etc.

   Potato, sweet, potato, colocasia, yams, alocasia

   Mango, guava, citrus, Mandarin orange, litchi, low chilling peaches, pears, plums, almond, aonla, Khasi mandarin.

   Rose, gladiolus, orchids, carnation, chrysanthemum, marigold, petunia, large number of other ornamental and foliage plants.

3. **Tropical zone** (Southern part of Jhowai, adjoining part of Karimganj, Cachar, North Cachar Hills of Assam, southern part of Nongpol, eastern part of east Garo hills and west Khasi hills, lower part of west Garo hills):

   Rice, maize, sugarcane, green gram, black gram, arhar.

   Brinjal, tomato, okra, beans (broad, bush, climbing), gourds (bottle, ridge, ash, bitter), amaranthus, cowpea, pointed gourd, bottle gourd, pumpkin, coccinia, vegetables (palak, methi, mustard).

   Cassava, sweet potato, amorphophallus, dioscorea, yam, coleus, colocasia etc.

   Turmeric, ginger, large cardamom, pepper etc.

Coconut, arecanut, cashew, oil palm, rubber, cocoa, tea, tree bean, coffee.

Mango, Assam lemon, citrus, banana, pineapple, papaya, grapes, sapota, water melon, snape melon, jackfruit, passion fruit, Khasi mandarin.

Rose, chrysanthemum, jasmine, marigold, gerberabalsum, orchids, tube rose, gerbera, anthurium.

Livestock

Piggery, Poultry, Duckery, Dairy.

Fisheries

Composite fish culture with 6 species (catla, rohu, calbasu, mrigal, grass carp, common carp,); Integrated Farming System: Fish-Pig-Veg, Organic-based Integrated Farming System etc.

Note: Location specific / season specific crops will be selected.

MIZORAM

CROPS

1. **Temperate zone** (Blue mountain, Halkhan, Turpang, Nauzuarzo, and Tiang):

   Rice, sesamum, maize, rice (Jhum), sweet corn.

   Cabbage, cauliflower, knol-khol, broccoli, radish, turnip, beetroot, carrot, garlic, onion, spinach, cucumber, tomato, brinjal, okra, French bean, bean, capsicum and peas.

   Apple, pear, peach, plum, cherry, pistachio, almond, apricot, walnut, chestnut and kiwi fruit.

2. **Subtropical zone** (As whole except lower valleys, adjoining area of Cachar and lower parts of Chhimtuipuii):

   Rice, sesamum, maize, rice (Jhum), sweet corn.

   Brinjal, tomato, okra, beans (broad, rajma, bush and pole French bean), gourds (bottle, ridge, ash, bitter), peas, carrot, radish, turnip, cole crops, vegetables (palak, methi, mustard), onion, garlic, chili, King chili, mustard and capsicum etc.

   Potato, sweet, potato, colocasia, yam, alocasia.

   Turmeric, ginger, large cardamom, pepper etc.

   Mango, guava, citrus, Mandarin orange, litchi, low chilling peaches, pear, plum, almond, aonla, dragon fruit, avocado.

   Rose, gladiolus, orchids, carnation, chrysanthemum, marigold, petunia, large number of other ornamental and foliage plants.

3. **Tropical zone** (Northern and western part, Chhimheipuii district):

   Rice, sesamum, maize, sweet corn. Brinjal, tomato, okra, beans (broad, rajma, bush and pole French bean), gourds (bottle, ridge, ash, pointed, bitter), coccinia,amaranthus, colocasia, cowpea, pumpkin, rajma, tree beanvegetables (palak, methi, mustard).

   Cassava, sweet potato, amorphophallus, dioscorea, yams, coleus, colocasia etc.

   Coconut, mango, Assam lemon, citrus, banana, pineapple, papaya, papaya, grape, sapota, water

melon, snape melon, dragon fruit, avocado.

Arecanut, cashew, oil palm, rubber, cocoa, tea, coffee.

Rose, chrysanthemum, jasmine, marigold, gerberabalsum, orchids, tube rose, anthurium, coccinea etc.

LIVESTOCK

Piggery, Poultry, Duckery, Goatery, Dairy, Buffaloes

FISHERIES

Composite fish culture with 6 species (catla, rohu, mrigal, silver carp, grass carp, common carp); Integrated Farming System: Fish-Pig-Veg etc.

Note: Location specific / season specific crops to be selected

NAGALAND

CROPS

1. **Temperate zone** (Tuensong and Zunebota, Vangkung and higher areas of Mokachung):

Maize and millet (85% of the cultivable land is occupied by cereals.),rice, black gram,green gram, arhar.

Cabbage, cauliflower, knol-khol, broccoli, radish, turnip, beetroot, carrot, garlic, onion, spinach, cucumber, tomato, brinjal, okra, French bean, beans (broad, rajma, bush and pole French bean), gourds (bottle, ridge, ash, bitter), capsicum and peas.

Pear, peach, plum, pistachio, almond, apricot, walnut, chestnut and kiwi fruit.

2. **Subtropical zone (**Mokachung district, lower parts of Kohima, Wokha, Monbhagti and Longhak valley):

Maize and millet (85% of the cultivable land is occupied by cereals.),rice, black gram,green gram, arhar.

Brinjal, tomato, okra, beans (broad, bush, climbing), gourds (bottle, ridge, ash, bitter),peas, carrot, radish, turnip, cole crops, vegetables (palak, methi, mustard), onion, garlic, chilies and capsicum etc.

Potato, sweet potato, colocasia, yam, alocasia

Mango, guava, citrus, mandarin orange,litchi, low chilling peaches, pears, plums, almond, aonla, mandarin orange.

Rose, gladiolus, orchids, carnation, chrysanthemum, marigold, petunia, large number of other ornamental and foliage plants.

3. **Tropical zone** (Medzephena area of Dimapur sub division, southern part of Dimapur and Jampuii area):

Maize and millet (85% of the cultivable land is occupied by cereals.),black gram. green gram, arhar, sugarcane.

Brinjal, tomato, okra, beans (broad, rajma, bush and pole French bean), gourds (bottle, ridge, ash, bitter),cowpea, amaranthuspumpkin, mustard, vegetables (palak, methi, mustard).

Cassava, sweet potato, amorphophallus, dioscorea, yams, coleus, colocasia etc.

Cardamom, cinnamon, cloves pepper, turmeric, ginger etc.

Tea, coffee, arecanut, cashew, oil palm, rubber.

Mango, citrus, Assam lemon, banana, pineapple, papaya, grapes, sapota, water melon, snape melon, mandarin orange, passion fruit.

Rose, chrysanthemum, jasmine, marigold, gerberabalsum, orchids, tube rose,gerbera, anthurium etc.

LIVESTOCK

Piggery, Poultry, Duckery, Goatery,Ddairy,Buffaloes, Mithun.

FISHERIES

1. **Temperate zone:** Composite fish culture with 6 species (silver carp, grass carp, common carp); Integrated Farming System: Fish-Pig-Veg, Fish (common carp)-Paddy.
2. **Subtropical zone:** Composite fish culture with 6 species (silver carp, grass carp, common carp); Integrated Farming System: Fish-Pig-Horti, Fish-Paddy etc.
3. **Tropical zone:** Composite fish culture with 6 species (catla, rohu, mrigal, silver carp, grass carp, common carp); Integrated Farming System: Fish-Pig-Horti.

Note: Location specific / season specific crops to be selected

SIKKIM

CROPS

1. **Temperate zone** (Gnathing, Chhangu, Serrathong, Lima, Zema, Karponag, Bordong, Resi, Kangdem, Melli param, LachemHilley and Yaksum):

   Maize (Southern Sikkim), rice (River valleys), wheat, barley and buck wheat (Southern and Central Sikkim), millets,black gram. green gram, red gram.

   Kiwi, Apple, pear, peach, plum, cherry, orange, pistachio, almond, apricot, walnut, chestnut, pecan nut.

   Cabbage, cauliflower, knol-khol, broccoli, radish,turnip, beetroot, carrot, garlic, onion, spinach, cucumber, tomato, brinjal, okra, French bean, bean, capsicum and peas.

2. **Subtropical zone** (Namchi, Gayzing, Rongli, Rehnok, Mangan, Changthong, Uttre and Gangtok):

   Maize, rice, wheat,millets, black gram. green gram, arhar

   Brinjal, tomato, okra, beans (broad, rajma, bush and pole French bean), gourds (bottle, ridge, ash, bitter), pea, carrot, radish, turnip, cole crops, onion, garlic, chili and capsicum vegetables (palak, methi, mustard).

   Potato, sweet potato, colocasia, yams, alocasia.

   Mango, guava, citrus, Mandarin orange, passionfruit, litchi, low chilling peaches, pears, plums, almond, aonla, dragon fruit, ber.

3. **Tropical zone** (Rongpoh area of east district):

Maize (Southern Sikkim), rice (River valleys), wheat, barley and buck wheat (Southern and Central Sikkim), millets,black gram. green gram, arhar

Brinjal, tomato, okra, beans (broad, rajma, bush and pole French bean), gourds (bottle, ridge, ash, bitter), cowpea, amaranthus,pumpkin, mustard, tree tomato, vegetables (palak, methi, mustard).

Cassava, sweet potato, amorphophallus, dioscorea, yams, coleus, colocasia etc.

Large cardamom, chilli, turmeric, coriander, ginger etc.

Tea, coconut, arecanut, cashew, oil palm, rubber, cocoa

Mango, citrus, Assam lemon, banana, pineapple, papaya, grapes, sapota, jackfruit, dragon fruit, ber.

Rose, chrysanthemum, jasmine, marigold, gerbera,balsum, orchids, tube rose, gerbera, anthurium, cymbidium, etc.

LIVESTOCK

Piggery, Poultry, Duckery, Goatery, Dairy, Buffaloes

FISHERIES

1. **Temperate zone:** Trout farming; Composite fish culture with 6 species (silver carp, grass carp, common carp); Integrated Farming System: Fish-Pig-Horti, Fish (common carp)-Paddy.
2. **Subtropical zone:** Composite fish culture with 6 species (silver carp, grass carp, common carp); Integrated Farming System: Fish-Pig-Horti, Fish-Paddy etc.
3. **Tropical zone:** Composite fish culture with 6 species (catla, rohu, mrigal, silver carp, grass carp, common carp); Integrated Farming System: Fish-Pig-Horti etc.

Note: Location specific / season specific crops to be selected

TRIPURA

CROPS

1. **Subtropical zone** (Jumpi Hills)

Rice, maize, black gram, green gram, arhar, rapeseed- mustard.

Brinjal, tomato, beans (broad, rajma, bush and pole French bean), gourds (bottle, ridge, ash, bitter), pea, carrot, radish, turnip, leafy vegetables, cabbage, cauliflower, onion,garlic, chili, capsicum, vegetables (palak, methi, mustard).

Potato, sweet potato, colocasia, yams, alocasia, Cassava, sweet potato, amorphophallus, dioscorea, coleus.

Mango, guava, citrus, litchi, low chilling peach, pear, plum, almond, aonla, orange, pineapple, jackfruit,ber.

Rose, gladiolus, orchids, carnation, chrysanthemum, marigold, petunia, large number of other ornamentaland foliage plants.

2. **Tropical zone** (major part of Tripura):

Rice, maize, sugarcane, black gram, green gram, arhar,rapeseed- mustard.

Brinjal, tomato, okra, beans (broad, rajma, bush and pole French bean), gourds (bottle, ridge, ash, bitter), amaranthus, pumpkin, cucumber, okra, cowpea, vegetables (palak, methi, mustard).

Turmeric, ginger, large cardamom, pepper, betel nut, coriander etc.

Coconut, arecanut, cashew, oil palm, rubber, cocoa, tea, coffee, cinnamom.

Mango, jackfruit, citrus, lemon, Assam lemon, banana, litchi, pineapple, papaya, dragon fruit, ber, aonla.

Rose, chrysanthemum, jasmine, marigold, gerbera,balsum, orchids etc.

LIVESTOCK

Poultry, Piggery, Duckery, Goatary, Dairy

FISHERIES

Composite fish culture with 6 species: catla, rohu, mrigal, silver carp grass carp, common carp; Other species introduced in Composite fish culture system (as per availability of seed): Calbasu, Japaniputi, Pabda, Prawn, Big head carp, Reba; Integrated Farming System: Fish-Pig-Veg, Fish-Duck-Veg. etc.

Note: Location specific / season specific crops to be selected

SOWING & PLANTING CALENDAR OF SOME CROPS OF NEH REGION

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Sl. No.	Crop Name	Sowing/ Planting Time												Sowing/planting Method
		J	F	M	A	M	J	J	A	S	O	N	D	
1	Rice- CAU R 1													Transplanting
2	Rice- CAU R 2													Transplanting
3	Rice- CAU R 3													Transplanting
4	Rice- CAU R 4													Transplanting
5	Ground nut													Drilling/Dibbling
6	Maize													Drilling/Dibbling
7	Mustard													Broadcasting/ Line sowing
8	Wheat													Line sowing
9	Sugarcane													Furrow/ Pit
10	Soybean													Line sowing
11	Amaranthus													Sown in rows
12	Alocasia (Elephant Ear Plant)/ Oal													Sown in rows
13	Beans (Broad)													Sown in double rows
14	Beans (Rajma)													Dibbling
15	Beans (Climbing)													Dibbling
16	Bitter gourd													Dibbling
17	Bottle gourd													Dibbling
18	Brinjal													Transplanting
19	Broccoli													Transplanting
20	Cabbage													Transplanting
21	Capsicum													Transplanting
22	Carrot													Drilling
23	Cauliflower (early)													Transplanting
24	Cauliflower (mid)													Transplanting
25	Cauliflower (late)													Transplanting
26	Chilli													Transplanting
27	Corn													Dibbling
28	Colocasia (Taro)													Sown in rows (Planting corms, suckers or by division)
29	Coriander													Broadcasting
30	Cowpea													Sown in rows
31	Cucumber													Sown in rows

Sl. No.	Crop Name	Sowing/ Planting Time												Sowing/planting Method
		J	F	M	A	M	J	J	A	S	O	N	D	
32	Elephant Foot Yam/ Oal													Dibbling
33	French bean													Dibbling
34	Garlic													Dibbling
35	King chili													Transplanting
36	Knol-Khol													Transplanting
37	Methi													Sown in rows
38	Okra (Ladies' finger)													Dibbling
39	Onion													Transplanting
40	Palak													Sown in rows
41	Peas													Dibbling
42	Potato													Dibbling
43	Pumpkin													Dibbling
44	Radish													Dibbling
45	Ridge guard													Dibbling
46	Sweet potato													Vine cutting
47	Tomato													Transplanting
48	Water melon													Dibbling
49	Assam lemon													Stem cutting/ Leaf- bud cutting/Air layering
50	Banana													Planting of sucker in pit
51	Khasi mandarin													Dibbling/ Planting in pit
52	Coconut													Sowing of nut (Dec. to Feb)/ Planting seedling in pit (March-April for high land condition & September-October for low land condition)
53	Guava													Transplanting
54	Jackfruit													Seeds sown in poly bags
55	Kiwi fruit													Transplanting
56	Litchi													Transplanting
57	Orange													Transplanting
58	Papaya													Transplanting
59	Pineapple (Kew, Queen)													Planting sucker
60	Mango													Air layering/ Grafting/ Transplanting
61	Cashew nut													Transplanting

VACCINATION SCHEDULE OF DIFFERENT ANIMALS

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1. Vaccination Schedule for Dog

Disease	Vaccine Type	Age		
		Initial Shot	Booster	Revaccination
Rabies	Inactivated	12 weeks	16 weeks	Annually
Parvo infection	Inactivated / multi-component live attenuated	6-8 weeks	10-12 weeks	
Canine Distemper	Multi-component Live attenuated			
Canine infectious Hepatitis	Multi-component attenuated CAV-2 or/& inactivated CAV-1			
Canine Parainfluenza	Multi-component Live attenuated			
Leptospirosis	Multi-component inactivated			
Canine Corona virus	Inactivated	8weeks	12 Weeks	

2. Deworming Schedule for Dog

Age	Schedule
6-12 weeks	Every Fortnight
12 weeks to 6 months	Every month
6 months to Adult	Every 3 months

3. Vaccination Schedule for Cattle, Sheep and Goat

Disease	Animal	Vaccine	Time of Vaccination	Immunity	Dose
Anthrax	Cattle, Sheep and Goat	Spoor	May –June	One season	1 ml S/C
Black Quarter		Formal Killed Vaccine			5 ml S/C for C 2 ml S/C for S & G
Haem orrhagic Septice mia		Oil adjuvant			5 ml S/C For C 2 ml S/C for S & G
FMD		Polyvalent tissue culture vaccine			3 ml S/C for C 1 ml S/C for S & G
Brucel losis	cattle	Strain 19(Live)	At 6-8 months of age	3-4 calvings	2 ml S/C
Sheep & Goat Pox	S & G	Skin scabs	Once in a year before monsoon	One year	
Entero toxaemia	S & G	ET vaccine	May-June	One year	5 ml S/C
PPR	S & G	PPR Vaccine	-	3 Year	1 ml S/C

Note - Before any vaccination deworming should be done for better immunity.

1. Vaccination Schedule for Broiler

Age	Disease	Vaccine	Route
4-5 days	Ranikhet Disease(RD)	Lasota/F1	Occulonasal/ Drinking water
12-14 days	Infectious Bursal Disease	IBD Live	Drinking water
26-30days	RD	Lasota/F1	Drinking water

5. Vaccination Schedule for Layer

Sl. No	Age	Vaccine	Route
1	1st Day	Marek's Disease	S/C
2	5th Day	Ranikhet Disease	I/O or I/N
3	7th day	Marek's Disease booster	S/C
4	10th Day	Debeaking	
5	12-14th Day	Marek's Disease intermediate	Eye
6	20-22nd Day	IBD plus	I/O or Water
7	27th Day	Lasota	water
8	30th Day	Infectious Bronchitis (IB)	water
9	42nd Day	Fowl Pox	Wing
10	47th Day	Deworming	water
11	52nd Day	Lasota	Water
12	64th Day	R2B	I/M
13	86th Day	Coryza/Fowl Cholera	S/C
14	93th Day	IB	Water
15	100Day	Debeaking	
16	110th Day	Deworming	Water
17	112th day	Lasota	water
18	126th Day	RD-Killing	S/C
19	280th Day	Deworming/Lasota	water

6. Vaccination Schedule for Pig

Disease	Age	Dose/Route	Immunity
Swine fever	3-6 weeks	1 ml I/M	1 year
Swine Erysipelas	2 months	2 ml S/C	1 year
FMD	2 months	2 ml S/C	1 year
Brucellosis	2 months	2 ml S/C	Life long
Swine influenza	At any age	1 ml S/C	6 wks

TEMPLATE FOR TECHNOLOGY INVENTORY

(*As per the technology, template may be modified suitably to include all the relevant points*)

Submit with maximum 2-3 pages with good quality photos

Name of the Discipline: Crop Improvement (CI)/ Crop Management (CM)/ Crop Protection (CP)/ Animal Husbandry (AH)/ Aquaculture (AC)/ Farm Machinery (FM)/ Post Harvest Technology (PHT)

TECHNOLOGY: NECTAR-.....- 00

1.	Name of the Technology	:	
2.	Source of the Technology	:	
3.	Year of Release	:	
4.	Detail description about the Technology	:	*Brief description, Specifications (if any), Methodology/ Recipe/ Processing method/ Flow Chart/ Layout & sketch/ Performance/ Impact..... etc.*
5.	Critical inputs/ equipments/ingredients required	:	
6.	Observation to be recorded	:	1. ..... 2. ..... 3. ..... 4. .....
7.	Target users/stakeholders	:	*Multi Technology Testing Centres (MTTCs)- CAU/ KVKs/Farmers/Companies/SHGs/NGOs/Entrepreneurs/Govt. agencies*
8.	Precautions in technology	:	
9.	Advantage of technology/variety/product	:	
10.	Economics of the Technology/ Benefit: Cost Ratio (BCR)	:	*Percent profit to turn over, BCR etc.*
11.	Technology developed under the project (if any)	:	*Specify the project name and funding agency*
12.	Investigator(s)/inventor(s)	:	*Name, Dept., College, Email, Mobile No.*
13.	Technology publication(s)	:	*Journal/Book/Annual Report/CAU Research Newsletter/ CAU Farm Magazine.....(submit detail reference)*
	Contact Address	:	*Dean, address, email*

NOTE:

1. Each Technology must be supported by good quality photographs (JPG); Layout & sketch (if any) etc.
2. Use only SI units, symbols & abbreviations with superscript (e.g., kg ha^{-1})

The AUTHORS

Prof. R. K. Saha

Prof. Ratan Kumar Saha (MSc, IFDA, DFSc, PhD, FZS) joined as Director (Extension Education), Central Agricultural University, Imphal, Manipur on November 10, 2017. Before that, he served as Assistant Professor, Associate Professor, Professor & Head (AHE), and Dean (Acting) in the College of Fisheries, CAU (I), Lembucherra, Tripura, India. Before joining CAU, Imphal he served in Divodaya Krishi Vigyan Kendra (ICAR Financed) as Training Associate (Fisheries), Khowai, Tripura, and Fishery Officer (Lecturer) in Tripura Fisheries Training Institute (TFTI), Department of Fisheries, Government of Tripura. He has more than 35 years of professional experience including administrative as well.

Prof. Saha has conducted several research projects as PI, sponsored by DST, NAIP (ICAR), DBT, NFDB, and CAU till date. At present working as Nodal Officer in ten (10) extension research projects running in the constituent colleges and university and also as Mentor in one DST project. He also guided several PG and PhD students, out of these two worked as DST Inspired fellow. He published a number of research papers in peer reviewed journals of national and international repute, authored 15 books, several chapters in books, training manuals, practical manuals, popular articles, leaflets, Pond Health Card, Fish Health Card, Fish Farming Calendar, Fish Breeding Calendar, Soil & Water Management Calendar, Digital Albums, and Video Clippings, etc. Prof. Saha has developed/ identified nineteen (19) novel traits/ species/processes/ technologies/ products/ concepts/ methodologies in the area of fisheries and aquaculture and some of the technologies/concepts are well excepted by the farmers of the NEH region.

He has organized several training programmes on soil and water quality management, fish based farming system, fish health management, induced breeding of fishes, biofloc technology, etc., four CAU Regional Agri Fairs, two Farmers' Science Congresses, two workshops on biocontrol, one agro-fair on Vibrant NE 2019, two CAU-Intercollegiate Games and Sports Meets, one CAU Youth Festival, two National Seminars at COF campus of CAU, Imphal and also first time started the 'Distance Education on Scientific Fish Culture' for farmers of Manipur. He is an external member of different committees in various institutions. He is the life member of several national/ international scientific fisheries/ ecological societies and also attended more than 100 seminars/symposium/workshop. He got many awards and also received the Fellow of Zoological Society (Kolkata); Fellow of Tropical Ecology. He is the Chief Editor of CAU Farm Magazine, CAU Newsletter, and CAU Kisan Diary.

Prof. E V Divakara Sastry

Dr. E. V. Divakara Sastry specialized in plant breeding and genetics besides being trained in forestry. Since 1982, he worked at S K N Agriculture University and Since 2016

working as working as Professor and Head, Department of Genetics and Plant Breeding, Central Agricultural University, Imphal. He was involved in the teaching all through his career and has been teaching Biometrical Genetics for the last 3 decades. He has also worked as Ex-patriate expert on Biometrics at Alemaya University (Presently Haramaya University), Ethiopia between 2003-2005 under World Bank-ARTP Project and has visited several institutions in Ethiopia as visiting professor. He has developed one variety in taramira (*Eruca sativa*) and 11 varieties in seed spices and several technologies related to spices. Besides seed spices, his other research interests include salinity tolerance in crop plants, dwarfism in wheat and fodder quality in pearl millet and post-harvest management in seed spices. He has published 117 research papers in peer reviewed Journals, 50 book chapters mostly on seed spices and has authored more than a dozen practical manuals. He has published four books on spices besides authoring a book on agricultural statistics entitled "Essentials of Agricultural Statistics". He has guided 12 Ph.D. and more than 40 MSc (Ag.) dissertation works. He has supervised several research projects to successful conclusion in India and abroad. He is a regular guest speaker on spices and education technology at different national and international fora. He is Fellow of National Academy of Biological sciences, Indian Society of seed spices, Indian Society of Genetics and Plant Breeding and Indian Society of Spices. He has conducted several National Seminars and Conferences on Seed Spices and has been chairman of various sessions at several National Seminars dealing with spices in the country. He was also on the Board of Directors of Post-Harvest Education foundation, USA, Vice President of Indian Society of Spices, Calicut and member of academic councils of several universities besides being on editorial board of several reputed National and International scientific journals.

Dr. S. M. Haldhar

Dr. Shravan M Haldhar (MSc, PhD) joined January 2020 as Associate Professor (Entomology) in Department of Entomology, College of Agriculture, Central Agricultural University, Imphal, Manipur. He started his career as Scientist (Agril Entomology) in ICAR in 2009 at CIAH, Bikaner. He born on 13th October, 1979 in Jaipur (Rajasthan), obtained M.Sc. Agricultural Entomology (2004) from RAU, Bikaner and Ph.D. (2008) from MPUAT, Udaipur. He has collected and identified around 95 insect species of horticultural importance in arid and semi-arid region, of which eleven species occurred on new hosts. He is also associated with development of 05 varieties of ridge gourd (Thar Karni); long melon (Thar Sheetal); sponge gourd (Thar Tapish); palak (Thar Hariparna) and ivy gourd (Thar Sundari) and registered two trait specific muskmelon genotype (AHM/BR-8) and watermelon genotype (AHW/BR-5) in NBPGR, New Delhi. He has published 11 international and 56 national research papers; 47 abstracts in seminar proceedings; 08 books; 14 compendium/ annual reports; 07 technical bulletin; 04 technical folder; 19 book chapters; 44 compendium chapters; 50 popular articles and delivered 72 lectures. He has handled the 02 externally funded projects as PI; 02 institute project as PI and 10 institute projects as Co-PI. He has conducted (23) and attended (35) seminar, conference, workshop and trainings in the country. He has editor of 07 international as well as national journals and life member of 08 different journals. He is fellow of 'The Entomological Society of India' and is the recipient of several awards and recognitions including Dr. B. Vasantharaj David Young Scientist Award 2019; Agriculture Today Young Scientist Award 2019; SAAER-Young Scientist Award 2016; AIASA-Scientist of the Year Award 2016 and IIFS-Rastriya Gaurava Award 2012. Dr. Haldhar has developed 33 technologies related to insect-pests management strategies in arid horticulture crops and applied one patent on biopesticde "Thar Jaivik 41 EC" for insect-pests management. Submitted 07 new DNA Bar-coding

sequence data of arid horticulture crops insects to Gene Bank NCBI, USA. Guided 05 Ph D and M Sc scholar. He has participated international symposium (TAAO) at University Putra Malaysia in 2016.

Prof. M. Premjit Singh

Professor M. Premjit Singh, Vice-Chancellor, Central Agricultural University, Imphal obtained his M.Sc. (Life Sciences) degree in 1981 from Jawaharlal Nehru University, New Delhi; M.Phil. and Ph.D. Degree in Zoology with specialization in Entomology from Himachal Pradesh University, Shimla. He started his career as Assistant Professor (Entomology) in 1986 in the erstwhile Manipur Agricultural College, Imphal and became Associate Professor in 1990, Professor in 1998, Director of Extension Education in 2009 and Vice-Chancellor, Central Agricultural University (CAU), Imphal during (18th December 2014 - 16th October, 2020). Besides professional positions, he also served as Registrar, Deputy Registrar (Academic), Assistant Registrar (Academic) and Research Coordinator (Oilseed Crops) in CAU, Imphal for more than a decade. He has undertaken 10 (ten) mega research projects and supervised 5 Ph.D. and 10 M.Sc. (Ag.) students and attended 8 international conferences, 82 national conferences and 5 advance training courses. He has published 100 research papers, 55 research communications, 6 books, 11 technical bulletins, 34 popular articles and 2 success stories. He was the Chief Editor of CAU Farm Magazine and CAU Kisan Diary published in 7 languages. Dr Singh has developed/identified 14 novel technologies/concepts/methodologies in the area of plant protection.

Large scale demonstration on "Zero tillage cultivation of rapeseed-mustard in rice fallow with bee pollination and non-chemical method of plant protection" with cost-benefit ratio of 1:3.4 covering more than 1000 ha for 6 consecutive years; Front Line Demonstration on location specific IPM in rice using gall midge and blast resistant rice variety with cost-benefit ratio of 1:2.1 in 200 ha for 5 consecutive years; construction of many water harvesting structures in Farmers' field with micro-irrigation facilities and quality seed production of rice and oilseeds under seed village concept are some of the exemplary contributions of Dr. Singh for the resource poor farmers of North-Eastern region.

After joining as Vice-Chancellor on 27.03.2015, Dr. Singh established 6(six) new colleges, 6(six) Multi-Technology Testing Centres and 6(six) Vocational Training Centres within 16 months for human resource development and skill development of unemployed rural youth in the north-eastern region. He also brought seven Mega Extension Projects and three KVKs for enhancing socio-economic status and livelihood security of poor farmers of North-Eastern Region.

Dr. Singh is recipient of Young Scientist Award, 1992 of DST; Dr Daulat Singh Memorial Extension Education Excellence Award, 2017; Mahindra Samriddhi India Agri National Award - 2017, ABP National Education Award, 2017, IAHF (Indian Association of Hill Farming) Honorary Fellow, 2015 and Life Time Achievement Award, 2017 of MOBILIZATION, Education Leadership Award, 2018 of DNA and Stars of the Industry Group, NEAST (North East Academy of Science & Technology) Founder Honorary Fellow, 2018, Life time Achievement Award,2018 of SEE, Agra.Dr. Singh is also the Life Fellow and Vice-President of Entomological Society of India, New Delhi.

About the book

The present book entitled "Inventory of CAU Technologies for NEH Region" is a compilation of all the technologies that were developed by Central Agricultural University (Imphal). The University which was enacted by Act No. 40 during 1992 by Govt. of India has been serving the farming community of North East of India since 1993. Central Agricultural University is the largest among Indian agricultural universities in terms of spread consisting of 13 colleges, 6 KVKs, 6 MTTCs, and 01 research station under its fold in seven states namely Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura.

The University since its inception has developed 133 technologies addressing the issues related to agriculture, horticulture, forestry, animal husbandry, fisheries as well as the issues related to rural communities including fabrication of machines to ease the farming tasks. The technologies also address the issues related to post-harvest management of farm produce for both value addition and loss prevention. Some of the technologies have already been commercialized helping to set up or strengthening agro-based industries in the region. The University is also in the process of obtaining patents for its technologies. Since agriculture, in general, is organic in the North-Eastern Region, most of the technologies developed are centered to this theme of agriculture.

Over the years, it was felt that a compilation of all the developed technologies should be done so that personnel who are in the process of dissemination of technology, line department personnel, and policymakers can have readymade solutions for the problems that they may be facing during their course of discharging of duties. Further, this book will also help such personnel to identify new issues that may require immediate attention through research so that the University can address such issues to find solutions.

For the convenience, all the technology has been grouped under 7 broad groups namely- crop improvement (9 technologies), crop management (12 technologies), crop protection (16 technologies), animal husbandry (10 technologies), aquaculture (18 technologies), farm machinery (42 technologies), and post-harvest technology (28 technologies). Further, information on agro-climatic zones of NEH region, crops/ breeds/ practices of NEH region, and vaccination schedule of different animals in the NEH region are also provided with important illustrations, coloured photos so that visual understanding becomes easy.

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