ISSN: 2279-0454

Vol. 9, No. 3
July - September, 2019

CAU Farm Magazine

A Quarterly Magazine of Central Agricultural University, Imphal, Manipur









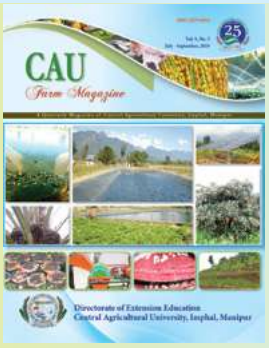
Directorate of Extension Education
Central Agricultural University, Imphal, Manipur

ISSN: 2279-0454
2279-0454
CAU Farm Magazine
Vol. 9 No. 3

Published by:
Director of Extension Education
Central Agricultural University, Imphal
Manipur - 795 004

www.cau.ac.in

For any queries and advertisement contact:
Chief Editor
CAU Farm Magazine
Tel: +91 385 241 3227
Fax: +91 385 241 3891
Email: cau.publicity@gmail.com



Cover page: *Jal Shakri Abhiyan*

The views expressed in the articles are of the authors and not of the Directorate of Extension Education, CAU, Imphal.

Layout & Design
Y. Premchand Singh
Computer Operator, DEE, CAU, Imphal

Technical Assistant
G. Amritkumar Sharma, Ph. Rahulnath Sharma, L. Momon Singh, Y. Sanjoy Meitei W. Khagemba Singh, Mrs. Narita L., & O. James Singh

Printed at
nest Advertising & Marketing Pvt. Ltd.
Babupara, Imphal - 795 004
Manipur, India
Printed on October 22, 2019

Pages in the Magazine: 41

From the Editor's Desk

Agriculture and allied is a vital and dynamic sector of the Indian Economy as more than half of its population depends on Agriculture as a principal source of income. In the changing scenario of climate, farming system research cum extension plays an important role in the generation and dissemination of agricultural technologies aiming at enhancing the income of farmers.

Furthermore, higher demand for quality agricultural produce is now anticipated and agriculture is not anymore about producing farm products and selling them exclusively at the local market. Instead of farmers today have a global market to serve, but the new changes bring new challenges. Farmers and agricultural enterprises, willing to be part of the new expanding global market, not only have to take into consideration of local consumers' or buyers' preferences whom they want to serve, but also adhere to regional, national and international market and comply with assured supply of high production and quality standards required by the importing states or countries.

With a view to this, a systematized, time-bound, season-based, and farm-oriented extension information/literature contributed by learned scientists and teachers for publication in the CAU Farm Magazine is a continuous process. In this present issue of the Magazine contains twelve (12) nos. of articles focusing over Jal Sakti Abhiyan, conservation of abandoned jhum field, improved farm mechanization, insect pests on lac insects, coconut-based farming, mushroom cultivation, on-farm production of beneficial fungus, multi-storied cropping system, climate-smart agriculture, and aquatic animal health management.

I would like to express my sincere gratitude to all the authors who supported this volume of publication and enabled making information available. This is a useful source of information for farmers, trainers, consumers, and other interested persons to improve not only agriculture but also the livelihood of the farming community.

The Hon'ble Vice-Chancellor and Patron of the Editorial Board have a keen interest and constructive vision for publication of this prestigious Farm Magazine of the University. Therefore, we would like to extend our heartfelt thanks to the eminent personality of the University.

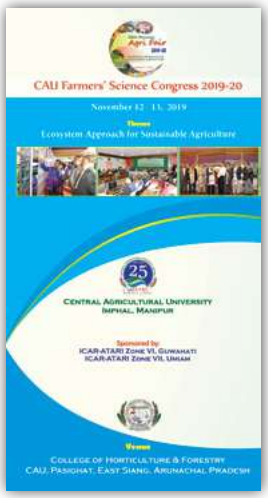
On behalf of the Extension Education Directorate and is the Chief Editor of the CAU Farm Magazine, I would like to thank all the members of the Editorial Board. I am also thankful to Mr. Y. Premchand Singh, Computer Operator; Mr. G. Amritkumar Sharma, Video- photographer, Mr. Rahulnath Sharma, and all other staff who have contributed to their level best to bring this issue on time.

(Prof. Ratan Kumar Saha)
Chief Editor

UPCOMING EVENTS

&
2nd FARMERS' SCIENCE CONGRESS

For details please see in the web site: www.cau.ac.in



ISSN : 2279-0454
July - September, 2019

CAU Farm Magazine

July - September, 2019
VOL. 9, NO. 3

CONTENTS

ISSN : 2279-0454
July - September, 2019

1

JAL SHAKTI ABHIYAN - A *JAN ANDOLAN* FOR WATER CONSERVATION

S. K. Pattanaaik, P. Heisnam, P. Debnath, J. Mohanty and B.N.Hazarika
College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh
Email: saroj_swce@rediffmail.com

Jal Shakti Abhiyan has been initiated under the Ministry of Jal Shakti, Government of India. This was formed in May 2019 with the special focus of Hon'ble Prime Minister's impetus on *Jal Sanchay*. *Jal Shakti Abhiyan* (JSA) is a time-bound, mission-mode water conservation campaign and has become a *Jan Andolan*. The detail of the programme is discussed in subsequent paragraphs. The importance of freshwater conservation is explained by following facts:

People wonder and think, why should we conserve water? They know that 71% of the earth is covered in water. The distribution of earth's water is as follows:

- Ninety-seven percent of all water on the earth is salt water, which is not suitable for either drinking or agriculture.
- Only 3% of water on earth is freshwater, and only 0.5% is available for use.
- The other 2.5% of freshwater is locked in ice caps, glaciers, the atmosphere, soil, or under the earth's surface, or is too polluted for consumption.

It only makes sense that we must preserve and conserve this precious resource. Water conservation means using our limited freshwater supply wisely and caring for it properly. Since each of us depends on freshwater to sustain life, it is our responsibility to learn more about water conservation and how we can help keep our sources pure and safe for generations to come. Advocating for the sustainable management of freshwater resources, World Water Day is celebrated every year on March 22. It was instituted in the year 1993 to build public awareness and involvement in protecting water resources around the world.

Water Crisis

Globally, close to four billion people live in water-scarce areas, where, for at least part of the year, demand exceeds supply. This number is expected to go up to five billion by 2050. Physical water scarcity is getting worse, exacerbated by growing demand on water resources and by climate and population changes. Nearly half the world's population lives with water scarcity. By 2050, nearly 20% of the world's population will be at risk of floods. By 2040, it is predicted that 33 countries are likely to face extremely high water stress - including 15 in the Middle East, most of Northern Africa, Pakistan, Turkey, Afghanistan and Spain. Many - including India, China, Southern Africa, USA and Australia - will face high water stress. As many as one billion people in India live in areas of physical water scarcity, of which 600 million are in areas of high to extreme water stress, according to a new report. India is currently ranked 120 among 122 countries in the water quality index.

Recent scenario of Tamil Nadu state of India, especially Chennai, Madurai cities are facing highest water crisis of the centuries and the drinking water is being imported from outside through rail wagons. The recurrent water stress of Vidarva, Maharastra, drying of river Mahanadi in Odisha and dispute between Karnataka and Tamil Nadu and many prediction of future water scarcity of Bengaluru, Delhi, etc. cities of the country necessitates planning and taking policy decisions for management of water resource of the country. The fresh water resource of India is given in Table 1.

Table 1 Water resources of India

Parameter	Unit (**billion m^3 y^{-1}**)
Annual water availability	1869
Usable water	1123
Surface water	690
Ground water	433

Source: Central Water Commission, Govt. of India

ISSN : 2279-0454
July - September, 2019

Major consumption of water is for agriculture, industrial production and domestic purposes, apart from being used for fisheries, hydro-power generation, transportation and maintaining biodiversity and ecological balance. The proportion of water used for agriculture and industries varies from country to country depending on the lifestyle, extent of industrial development and water use efficiency as presented in Table 2. Developing countries are using comparatively less water for agriculture and more for industrial and domestic purposes, while the developing countries in Asia and Africa use 80-90% of the water for agriculture and only 5-12% of the water for industrial use. This is reflecting on inefficient use of water in agriculture and poor investments in industrial development. With the urbanisation and industrial development, the usage of water is likely to increase in the coming years as presented in Table 3. While the per capita water use in India will increase from the current level of 89 litres per day to 167 litres per day in 2050, the per capita consumption in USA will reduce from 583 litres to 485 litres per day in 2050. By then, India will be the highest water demanding country, needing 2413 litres day^{-1}, while China and USA would require 2192 billion litres and 1167 billion litres respectively.

Table 2 Current water usage (%)

Usage	World	Europe	Africa	India
Agriculture	69	33	88	83
Industry	23	54	05	12
Domestic	08	13	07	05

Table 3 Future Water Usage

Country	Year	Agriculture	Industry	Domestic	Total	Per Capita
India			billion lit day^{-1}			lit day^{-1}
	2000	1658	115	93	1866	88.9
	2050	1745	441	227	2413	167.0
China						
	2000	1024	392	105	1521	82.7
	2050	1151	822	219	2192	155.4
USA						
	2000	542	605	166	1313	582.7
	2050	315	665	187	1167	484.6

India is blessed with good rainfall well distributed over 5-6 months in the year. The average annual rainfall in the country is 1170 mm with a wide range between 100 mm in desert areas of Rajasthan to 10000 mm in Cherapunji. The total available sweet water in the country is 4000 billion m^3 per annum. Out of this, over 1047 billion m^3 water is lost due to evaporation, transpiration and runoff, reducing the available water to 1953 billion m^3 and the usable water to 1123 billion m^3. It is disturbing to note that only 18% of the rainwater is used effectively while 48% enters the river and most of which reaches the ocean. Out of the total usable water, 728 billion m^3 is contributed from surface water and 395 billion m^3 is contributed by replenishable ground water. Against the above supply, the water consumed during the year 2006 in India was 829 billion m^3 which is likely to increase to 1093 billion m^3 in 2025 and 1047 billion m^3 in 2050, as estimated by the Government of India (2009). As the potential for increasing the volume of utilisation of water is hardly 5-10%, India is bound to face severe scarcity of water in the near future.

While water for consumption is most crucial, it is equally important to provide water for irrigation to increase the food production and livestock husbandry, to ensure food security for the increasing population. Growing population, as everyone is aware, is a serious concern as it will create further burden on the per capita water availability in the future. As can be seen in Table 4, the per capita water availability in 1951 was 5177 m^3 y^{-1} when the total population was only 361 million. In 2001, as the population increased to 1027 million, the per capita water availability reduced drastically to 1820 m^3 per year. By 2025, the per capita water availability will further drop down to 1341 m^3 and to 1140 m^3 in 2050. Based on the average requirement of water for various purposes, the situation is considered as water stress condition when the per capita water availability ranges from 1000 to 1700 m^3 y^{-1} and it is considered water scarcity when the availability reduces to 1000 m^3 y^{-1}. As the water available within the country varies widely as a result of rainfall, ground water reserve and proximity to river basins, most of the Indian states will

ISSN : 2279-0454
July - September, 2019

have reached the water stress condition by 2020 and water scarcity condition by 2025. This would further hamper the food security, as the scarcity of water will directly suppress agricultural production.

Table 4 Per capita water availability in India

Year	Population (million)	Per capita water availability ($m^3 y^{-1}$)
1951	361	5177
1955	395	4732
1991	846	2209
2001	1027	1820
2025	1394	1341
2050	1640	1140

Source: Government of India, 2009

India - Third Largest Exporter of Groundwater

Global groundwater depletion - where the amount of water taken from aquifers exceeds the amount that is restored naturally - increased by 22 percent between 2000 and 2010, said the report, adding that India's rate of groundwater depletion increased by 23 percent during the same period.

The report also highlighted that India uses the largest amount of groundwater 24% of the global total, more than that of China and the US combined - and is the third largest exporter of groundwater 12% of the global total.

Water Scarcity can't be Fixed without Fixing Agriculture in India

According to the report, wheat and rice were the two most important and highest water-guzzling crops that India produced. "Rice is the least water-efficient grain and wheat has been the main driver in increasing irrigation stress. Replacing rice and wheat with other crops like maize, millets, sorghum mapped to suitable geographies could reduce irrigation water demand by one-third," said the report. Though replacement of rice and wheat crops is challenging, in an ideal scenario, the choice of crop needs to be matched with ecology and the amount of water available in the area it is being produced. Noting that one kg of wheat required an average 1,654 litres of water, the report said one kg of rice requires an average 2,800 litres of water." So, just for rice, a family of four consumes approximately 84,600 litres of virtual water in a month," it added.

"In 2014-15, India exported 37.2 lakh tonnes of basmati. To export this rice, the country used around 10 trillion litres of water, meaning India virtually exported 10 trillion litres of water,". UNESCO's report ahead of World Water Day on 22 March should serve as a wake-up call for every Indian. It highlights how India is staring at a deepening water crisis with few steps being taken to ameliorate this bleak situation. It predicts an intensified water crisis across the nation by 2050, with many parts of central India battling a withdrawal of 40 percent of the renewable surface water resources.

The Central Pollution Control Board has doubled the number of 'polluted' rivers from 121 to 275 in the last five years, blaming the huge quantities of untreated sewage being dumped into our rivers for this state of affairs. The situation is no better in the country where the quantum of water in the main rivers is much reduced. "Already, farmers in Andhra Pradesh have been asked not to grow water-intensive crops such as paddy and sugarcane but rather to grow crops which require less water,"

Unregulated agriculture and over-drafting of water from the floodplain would have the even more serious consequence of reducing water levels in our aquifers. If these fall below the level of water in the rivers, the pollution from the rivers will seep in and completely destroy the aquifers, which are irreplaceable.

Agriculture production is highly dependent on water and increasingly subject to water risks. It is also the largest using sector and a major polluter of water. Improving agriculture's water management is therefore essential to a sustainable and productive agro-food sector.

Frequent droughts in many parts of the country have affected agricultural production while diminishing surface and groundwater reserves. These and other extreme weather events, like floods or tropical storms/ cyclones, are also expected to be more frequent. Climate change is projected to increase the fluctuations in precipitation and surface water supplies, reducing snow packs and glaciers and affecting crop's water requirements.

Jal Shakti Abhiyan

Inspired by the Hon'ble Prime Minister's impetus on *Jal Sanchay*, the *Jal Shakti Abhiyan* (JSA) is a time-bound, mission-mode water conservation campaign. During the campaign, officers, groundwater experts and scientists from the Government of India will work together with State and district officials in India's most water-stressed districts for water conservation and water resource management by focusing on accelerated implementation of five target intervention. The JSA aims at making water conservation a *Jan Andolan* through asset creation and extensive communication. The *abhiyan* is divided into two phases in the country:

Phase I: 1st July to 15th September 2019 (all States & Union territories)

Phase II:1st October to 30th November 2019 (States & Union territories with retreating monsoon: Andhra Pradesh, Karnataka, Puducherry and Tamil Nadu)

Intervention Areas

1. Water conservation and rainwater harvesting
2. Renovation of traditional and other water bodies/ tanks
3. Reuse and recharge structures
4. Watershed development
5. Intensive afforestation

Special Intervention Areas

- Block and District Water Conservation Plan: Development of Block and District Water Conservation Plans (To be integrated with the District Irrigation Plans).
- Kisan Mela: Krishi Vigyan Kendra will be organised Melas to promote efficient water use for irrigation (Per Drop More Crop), and better choice of crops for water conservation.
- Urban Waste Water Reuse: In urban areas, plans/ approvals with time bound targets to be developed for waste water reuse for industrial and agriculture purposes. Municipalities need to pass by-laws for the separation of grey water and blackwater.
- Scientists and IITs: Scientists and IITs to be mobilised at the national level to support the teams.
- 3D Village Contour Mapping: 3D Village Contour Maps may be created and made accessible for efficient planning of interventions.

Augmentation and Conservation of Water Resources

The freshwater resources of the country can be augmented by the following efforts. Under *Jal Shakti Abhiyan*, Govt. of India has initiated the conservation of freshwater resources by the following methods in the form of *Jan Andolan*.

Increasing Water Storage Capacity

Activities such as farm ponds, percolation tanks, water reservoirs and construction of small and medium size dams and rivers can retain more surface water, while increasing the ground water recharge. Series of contour bounds particularly in undulating areas will facilitate percolation of water in the soil and improve the ground water table, while reducing soil erosion. Gully plugging, construction of series of small dams on rivulets will help in storing water in reservoirs.

Efficient Irrigation Practices

Efficiency in irrigation is most essential, if the country wants to face the challenge of water crisis. As most of the crops are watered through flood irrigation, over 50% of the water used for irrigation is wasted even if lined channels are used in command areas. Furthermore, as the water supplied is not measured, farmers have a tendency to flood the field with excessive water without any additional cost. Such a practice has been creating a negative impact by way of increased cost of leached nutrients, pollution of ground water, increase in soil salinity and increase of pests and diseases. It is high time that India compels the farmers to adopt micro-irrigation systems, which will not only reduce the water requirement but also bring down the cost of production, while increasing the area under irrigation.

Watershed Development

Development of watersheds is an important programme to make best use of the rainwater for agricultural production while improving soil conservation and biodiversity. Fortunately, the Government of India has given top priority for watershed development to provide assured water supply of agriculture in rain fed areas. Under the watershed development programme, the catchment area of a basin is considered as a unit and efforts are made to harness rainwater by treating the land from the ridge to the valley. It is estimated that over 63% of the cultivated lands in the rain fed areas need to be brought under watershed development to conserve soil and water, which in turn would improve the crop yields as well as ground water table.

Control of Water Pollution

Excessive use of water for agriculture, industries and domestic uses is leading to water pollution, because such excess water is transformed into saline water, sewage or effluent. Thus, rewards and punishments should be introduced for persuading people to make optimum use of the precious water. Discharge of sewage and affluent into water bodies and rivers must be banned and recycling of waste water must be pursued and enforced. This will help in keeping the water sources clean and reducing the future demand for water. Treated sewage and effluent can be used for agriculture and industrial production.

ISSN : 2279-0454
July - September, 2019

Desalination of Sea Water

Over 70% of the global water resources being saline, economic desalination of sea water is an excellent option to meet the future shortage of sweet water particularly to meet the human consumption. Presently, desalination of sea water is expensive and non-popular. However, with solar power, desalination can be a viable alternative to meet the water needs in coastal areas.

Research and Development

There is a need for investing in research related to ground water monitoring, weather forecasting, breeding water efficient and drought resistant crops and varieties which can cope up with the changing climatic conditions, arising due to global warming.

A Case Study (Figs. 1 to 12)

An experience on the rainwater management technology implemented at the College of Horticulture and Forestry, Pasighat, East Siang, Arunachal Pradesh is discussed here. Porous, gravely and sandy soil is characterized by low water-holding capacity and excessive drainage of rain and irrigation water below the root zone, leading to poor water and fertilizer use efficiency by the crops. The soil of Arunachal Pradesh is of such nature. The soils have very less clay content (<20%), and are unable to hold water. The horticultural crops are subjected to acute water stress during five months from November to March, which is one of the reasons of low productivity. Non-veg food habit of the people needs pisciculture for rearing fishes. The pisciculture in these soils is difficult as storage of water is not possible. The high rainfall (average annual rainfall of 4200 mm) of the state can be managed well through harvesting of rain water by polyethylene lined water harvesting pond (WHP).

The construction of RCC made water harvesting pond is costly and needs skill in its design and its construction takes a long time. Construction of polythene lined WHP is an alternative to this. Utilization of unused naturally depressed areas can be converted into polythene lined water harvesting pond. The hydrologic, hydraulic and structural design of the water harvesting pond is made first. Then proper site is selected. The excavated gravely/ stony soil is kept as an embankment surrounding the pond. A trench of at least 1' × 1' is made surrounding the upper surface of the pond. The surface of the pond is then laid by 10-15 cm soil cushioning with subsequent laying of 250 GSM finish size silpaulin film. It is found that the pond can be made full of water by *in-situ* rainwater harvesting as the a.a.r is 4200 mm considering all losses. The construction work should be completed before the onset of monsoon (prior to March – April). The harvested water can be used for life saving irrigation as well as pisciculture activities successfully. Microirrigation system can be effectively used for life saving irrigation. It was found that the horticultural crops can be irrigated very well during the water scarce months. It has been observed that Oil palm (*Elaesis guineensis*) variety Tenera has shown good growth in the porous and gravelly soils due to the fact that the crop are well irrigated and fertigated. The micro-jet irrigation is successfully provided to the oil palm crop by utilizing the harvested water from the water harvesting pond. The eleven years old irrigated oil palm crop has productivity of 25.8 t ha^{-1}. The litchi crop is irrigated by the trickle irrigation system using the harvested water from the WHP. The yield obtained from seven years litchi old plant was 24 kg $plant^{-1}$. In case of vegetables like french bean, cowpea, pea, cauliflower, cabbage, okra, greenhouse cultivated king chilli, and potato, productivity of 1, 1.1, 1.5, 2.0, 3.19, 4.2, 9.3 and 28.6 t ha^{-1} is obtained by getting irrigation from solar pump operated micro-irrigation system. Similarly mean yield of fishes from the silpaulin lined pond is 15.1 q ha^{-1} by practicing composite fish farming system. Average total cost of production per ha is found to be Rs. 1,30,000 and benefit-cost ratio is 1.91. Fish species *viz*., Silver carp, Catla and Grass carp shows better growth in the polythene lined pond in comparison to Common carp, Rohu and Mrigal. The average life of the silpaulin lined pond is about five years and the cost per litre of storage of the water is less than 50 paise.

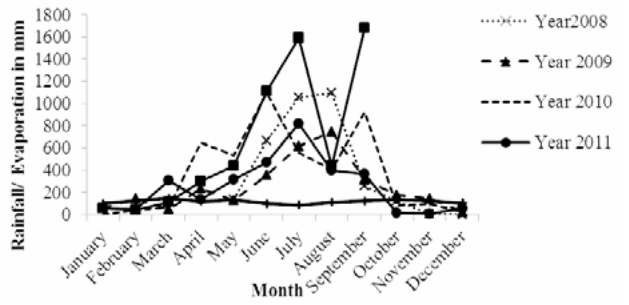


Fig. 1 Monthly variation of rainfall vs evaporation showing the dry months as Pasighat, Arunachal Pradesh

Fig. 2 Sandy, porous and gravelly soil

ISSN : 2279-0454
July - September, 2019

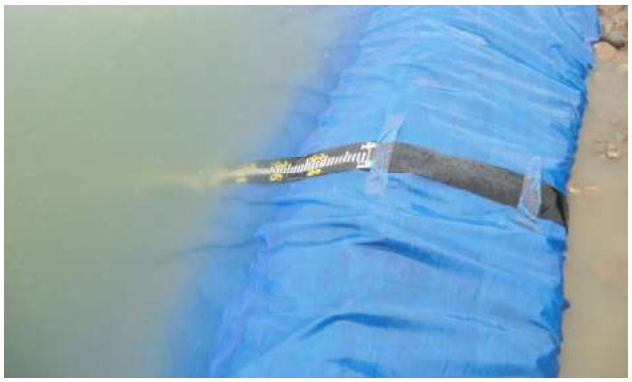


Fig. 3 Harvesting of *in-situ* rain water in the water harvesting pond

Fig. 4 SPV Modules

Fig. 5 Submersible solar pump in floating platform

Fig. 6 Solar based low cost drip irrigated cowpea

Fig. 7 Solar operated sprinkler irrigation in potato field

Fig. 8 Solar operated low cost drip irrigated cabbage

Fig. 9 French bean cultivation near WHP

Fig. 10 Practicing composite fish farming in WHP with average yield 15.1 q ha^{-1}

ISSN : 2279-0454
July - September, 2019

Fig. 11 Micro-irrigation system in oil palm crop (6 yr old - 25.8 t ha^{-1})

Fig. 12 Micro-irrigation system in litchi crop (7 yr old-30 kg plant^{-1})

Conclusion

Govt. of India has been attempting in conservation of water through various schemes/ initiatives. One of such initiative is *Jal Shakti Abhiyan*. People participation is essentially required for making the initiative fruit full. People of the country should be awared about the benefits of water conservation for their future generation. Ample scope exists in harvesting rainwater by different methods in North-East India. The precious rainwater should not be wasted into rivers and finally into oceans which causes top fertile soil erosion and loss of freshwater. Even if the region receives very high rainfall during *Kharif* season but the crops are water stressed during rabi season. The *Jal Shakti Abhiyan* should be made as a Jan Andolan in North-East region also. The farmers should be involved in this Abhiyan. Rain water harvesting in water harvesting pond can be one of the major steps under this initiative. The harvested water from the WHP can be utilized for irrigation by solar operated pump in micro-mode.

ISSN : 2279-0454
July - September, 2019

2

CONVERSION OF ABANDONED *JHUM* FIELDS FOR SEDENTARY AGRICULTURE: WAYS AND MEANS

Jamkhogin Lhungdim
College of Agriculture, CAU, Imphal, Manipur
ginlhungdim@rediffmail.com

Jhum cultivation is known by different names in different parts of the world as 'shifting cultivation', 'slash and burn' agriculture and 'bush fallow' agriculture. It is practiced in Indonesia, Philippines, Central America and Mexico, Vietnam, Venezuela, Brazil, Congo and Central Africa Korea and Southwest China. In India, it is known as '*Jhum*' or '*Jhoom*' cultivation in the hilly states of Northeast; as *Podu, Dabi, Koman* or *Bringa* in Orissa; as *Kumari* in Western Ghats; as *Watra* in Southeast Rajasthan; as *Penda*, *Bewar* or *Dahia* and *Deppa* or *Kumari* in the Bastar district of Madhya Pradesh. It is called shifting (*Jhum*/*Jhoom*) because farmers shift to the new location every year due to loss of the soil fertility in the first instance. In this cultivation, the plants and the forest on the land covering is cleared burnt and seeds are sown directly by dibbling. In the past, the cycle of *jhum* cultivation was very long from 25 to 35 years. But today, the cultivated land is revisited for cultivation 5 to 6 years due to the increased human population and limited land forest.

Evils and Merits of *Jhum* Cultivation

Environmental degradation leading to global warming, top soil loss leading to land/mudslides, disturbance in biodiversity, loss of valuable flora and fauna, wild fire outbreak,besides comparatively low yield are major negative impacts of *jhum* cultivation. Safe foods (being organic in nature), diversified cropping system, low labour and input use (due to supplemental nutrients from ashes of burnt biomass), etc. are few merits in *jhum* cultivation.

Fig. 1 *Jhum* field burning

Fig. 2 *Jhum* field just after burning

Crop Diversity

By default, *jhum* farmers are adopting undefined multi-cropping system incorporating crops of summer/ *kharif* seasons, *viz*., upland rice, cucumber, pumkin, lady's finger, colocassia, giner, turmeric, chilli, bitter gourd, spongegourd, ash gourd, etc. Mixed cropping is prevalent in the cultivation system. These diversified crops have different purposes ranging from family consumption to family income generation.

Improving *Jhum* Cultivation

Concerted efforts need to be addressed on the social and human aspects of the problem of *jhuming* and offer alternatives acceptable to the farmers in consultation with the local farming communities are mandatory. The concept of one year cultivation on *jhum* fields and abandoning for new fields every year have to be changed to widen *jhum* cycle. Same spot cultivation for years (sedentary agriculture) have to adopted with soil fertility replenishment through additional plant nutrients either by organic manures or soil enriching leguminous crops. This would offer a wider period between two field shifts thereby reducing the environmental degradation, destruction of precious flora and fauna. The following measures may be taken up to convert the abandoned *jhum* fields into a productive sedentary agricultural system:

Seasonal cultivation

a) Harvesting rains for *rabi* crops: *Jhum* fields which are in higher elevation are devoid of rain water during

ISSN : 2279-0454
July - September, 2019

Fig. 3 Water harvesting pond in abandoned *jhum*

rabi season. This has crippled the cultivation of crops as winter rains are very rare. Legumes which are low water requiring are suitable, *viz*., broadbean, peas, chickpea, lathyrus etc. These crops hardly survive if no winter rains are received. Hence, farmers do not visit the abandoned *jhum* fields just after harvest of the rice crop. Water from the nearly streams can be utilized by either PVC pipes or traditional bamboo water carriers. Water harvesting ponds can be constructed at highest elevated point of the field to discharge.

Fig. 4 Upland rice-groundnut intercropping

b) Choosing rainfed crops for *kharif* season: Any leguminous/cereals crops of *kharif* seasons can be cultivated. Soybean, blackgram/greengram can be cultivated between the semi perennial fruit crops like pineapple plants, maize can be intercropped with ricebean, cowpea, arharetc. The leguminous crops can be rotated with cereal crops without additional fertilizers. The high remunerative crops alternated with such food crops like upland rice, maize or millets would have a far reaching implication on the socio-economic development of the *jhum* farmers.

Planting Geometry

a) Planting along the slope is a traditional sowing/ planting method in the hill slopes owing to easier weed management than planting across the slope. This however, favours land degradation, top soil loss accompanied by decreased soil fertility.

b) Planting across the slope stops the sliding stop soil and favours soil conservation. Farmers can be motivated to adopt this method. The crops act as a 'live-bunds' to save top soil and nutrient from the field.

Fig. 5 Different planting geometry of Pineapple

Land Configuration

Low dimension *terraces* across the gentle hill slopes of the field can be created to sow crops like peas, broadbean, chickpea, etc in *rabi* season if irrigation from the nearby streams are available or water harvesting in ponds are constructed. In *kharif* season with assured rainfall, all sorts of crops can be cultivated. Groundnut can be cultivated in the terraces, arhar or soybean can be adjusted in the bunds. Terraces conserve soil, water and nutrients. Hal-moon method of planting for fruit crops like citrus, mango, guava, plum, peach, pear etc. may be adopted in the abandoned field with highest elevation.

Fig. 6 Terrace cultivation

Conclusion

Jhum cultivation contributes a fair share to global warming, disturbs ecosystem and imposes a big threat to ecological stability. However, the *jhum* farmers are left with no option due to inherited traditional system of the cultivation. They need to be motivated towards improved system of *jhum* cultivation gradually as an abrupt shift to the scientific cultivation may give a sense of food insecurity. Land modification, crop changeover, improved cropping system, cropping pattern and seasonal adjustment at the era of climate change are need of the hour. Changing the crop and not the field every year would be a boon towards sustainable income generation to the *jhumias* besides achieving environmental serenity.

ISSN : 2279-0454
July - September, 2019

3

POTENTIAL IMPROVED EQUIPMENT FOR ADOPTION IN NORTH EASTERN REGION

Jakendra Yumnam[1], R. K. Tiwari[2], S. K. Satpathy[2], M. Din[2] and S. K. Chauhan[2]
[1] *College of Food Technology, CAU, Imphal, Manipur*
[2] *Central Institute of Agricultural Engineering, Bhopal, Madhya Praesh*
Email: rk96tiwari@gmail.com

Mechanization study and data base development for agricultural machinery and manufacturers are of prime importance in the North - Eastern Region. Development and testing of a self-propelled pineapple harvester is the task which can fulfill dreams of farmers in the region. Multiplication of selected prototypes and their supply to other locations in the region can help in bridging the mechanization gaps. Large-scale demonstration of selected farm implements and machinery at farmer's fields is the demand of time to obtain feedback for design refinement and popularization of developed research prototypes in the region.. Training of artisans, rural youth, entrepreneurs, farmers, agricultural extension workers, small manufacturers can accelerate pace of development for selective mechanization. .

Agricultural equipment technologies have an economic impact in monetary terms to the tune of about Rs. 2200 Crore per annum. The benefits due to fatalities reduction in agriculture is about Rs. 84 crores per annum in the country. The use of improved animal drawn technologies, developed is about Rs. 100 Crore per annum over the traditional practices.

Few suitable equipment which have scope for promotion are mentioned below:

Harness for Single Animal

G B P U A T, Pantnagar has developed a collar harness for single animal for farm operations and transport. It is designed to fit on three sides of neck of animal which has two clamps for attaching to implement/cart. These harnesses have been demonstrated through front line demonstration for its popularization in Sikkim.

Fig. 1 Collar harness

AAU Manual Multi Crop Seed Drill

AAU Jorhat centre of AICRP on FIM has developed manual multi crop seed drill suiting to regional requirement in Assam. It is suitable for sowing green gram, black gram, chickpea, okra and maize using interchangeable seed plates. Two rows pull type gender friendly unit has overall dimension of 780 x 290 x 370 mm. It consists of seed metering inclined plate with cells made of rigid plastic. The unit is fitted with shoe type furrow openers, 'T' shaped handle (760 x 330 mm) and 'V' shaped seeds covering device. Power transmission is arranged through positive circular movement with ground wheel. The row spacing can be adjusted from 200 to 300 mm. There is provision for depth adjustment for furrow openers and seed covering device. The equipment provides effective field capacity and field efficiency of 0.16 ha h^{-1} and 82-84%, respectively.

Animal Drawn Garlic Planter

An animal drawn three row garlic planter having cup type metering mechanism has been developed at CIAE, Bhopal for sowing of garlic. The height of seed drop has been kept the lowest possible at 300 mm to minimize negative velocity to the garlic clove which affected seeding uniformity. Height of hopper box is adjusted with the help of lifting rod handle assembly to control the quantity of cloves in metering box. The average draught requirement is 450 N and the average effective field capacity is found to be 0.08 ha h^{-1} with 70% field efficiency. There is a saving of 90% of time and 80% in cost of operation as compared to conventional method of sowing.

ISSN : 2279-0454
July - September, 2019

Power Tiller Operated Multi-crop Seed Drill cum Planter for Hilly Region

CAEPHT Gangtok centre of AICRP on FIM has developed multi-crop seed drill cum planter for sowing small as well as bold seeds under terrace condition. The overall dimensions of unit are 680 x 802 x 800 mm and its weight is 26 kg. The main frame, two furrow openers, ground wheel, planter cum seed drill, handle, chain and sprockets for power transmission are salient features of the light weight unit. The machine consists of plastic rotor with cells on its periphery to pick up the seeds.

Fig. 2 Multi-crop seed drill cum planter

For Maize planting, effective field capacity varies 0.0.05-0.06 ha h^{-1} and field efficiency ranges 78-82%, respectively. The unit price of machine is Rs 7000 and cost of operation is Rs. 1840 ha^{-1}. There might be seed saving of 10-12% of maize seeds and 45-55% time saving due to sowing of two rows in single pass as compared to sowing behind country plough. There may be average net saving of 46.5% in cost of operation for maize as compared to traditional practice of sowing behind country plough.

Mechanization Package for Kodo (*Paspalum scrobiculatum*) and Little Millet (*Panicum miliare*) Cultivation

The mechanization package for kodo (*Paspalum scrobiculatum*) and little millet (*Panicum miliare*) for sowing, interculture and threshing operations have potential for benefiting stake holders. The improved package of sowing include manually operated single row seed-cum-fertilizer planter and bullock drawn three row seed-cum-fertilizer drill. The effective field capacity of manually operated single row seed cum fertilizer planter with vertical rotor metering mechanism for seeds and fertilizer is around 0.04 ha h^{-1}. The cost of operation is approximately Rs. 2500 ha^{-1} and may result in saving of 70% in seed for kodo and little millet as compared to traditional practice. The bullock drawn three row seed cum fertilizer drill of 55 kg weight has an effective field capacity of 0.11- 0.13 ha h^{-1}. The metering with vertical rotor ensures about 70% seed saving over traditional broadcasting. The cost of operation may be Rs. 500-600 ha^{-1}. The small thresher for mechanized threshing has threshing capacity of 100-120 kg h^{-1} with negligible grain damage (less than 3%).

Power Tiller Operated Potato/Ginger Digger

CAEPHT, CAU, Gangtok has developed digger for potato for digging efficiently in hilly condition. It consists of a blade, side support frame, hitching frame and soil separation unit. The V-shaped (45°) digging blade has been fabricated with mild steel plate of 350×250×4 mm. For hitching, two mild steel flats of 35×50×6 mm are mounted to the hitch point of the power tiller and connected to the frame consisting of two parallel mild steel flats of 800×50×6 mm. For soil separation, six mild steel rods of 10 mm diameter having a length of 200 mm are attached to the blade along the direction of travel. The digger can dig potato at 100-150 mm depth satisfactory. The average field capacity of equipment is 0.012 ha h^{-1}. The damage to potato may be below 5% and average potato exposure is 85%. The average fuel consumption may touch 0.8-1.0 l h^{-1}.

Light Weight Powered Paddy Thresher cum Cleaner

A light weight paddy thresher cum cleaner has been developed by ICAR, Barapani Centre. It consists of main frame, threshing unit, blower, sieving unit and power transmission unit of single phase 0.75 kW electric motor. Threshing unit consists of cylinder fitted with wire loops. Different components of blower, sieve shaker and threshing cylinder are incorporated to the main frame. The power transmission system with appropriate size of V-belt and pulley has been fabricated and assembled for operating the threshing

Fig. 3 Light weight powered paddy thresher cum cleaner

ISSN : 2279-0454
July - September, 2019

cylinder, sieving unit and blower. The separation of paddy grain from the straw is achieved due to combing action of the wire loops fitted on the threshing cylinder. The separated grains fell on the vibrating screen through the cleaning duct. A blower is used to blow off the chaff, dust and other light foreign materials from the grain. The vibrating screen separate sand, weed seeds and other heavy weight smaller size impurities. The average values of threshing efficiency, grain output capacity and losses due to shattering of the machine are 99.2%, 143 kg h^{-1} and 2%, respectively.

Cattle Dung Collector

Fig. 4 Cattle dung collector

To facilitate cleanliness and sanitation in animal farms, G B P U A T Pantnagar Centre has developed a dung collection machine to collect the dung from the floor of cattle yard for its safe disposal. The two versions of the machine are available, first can be operated with a 1hp electric motor while second model can be operated with 1.5 hp diesel engine. It consists of frame, endless conveyor belt mounted on roller, transport wheels, power transmission system and dung collection box. Three no. endless canvass belts are mounted on the conveyor belt. These are made of rubber pads and mounted on MS angle iron. Capacity of box is 225 kg for electric operated model and 105 kg for engine operated model. A depth control wheel of 200 mm is provided at the rear. The scraper blades mounted on the conveyor belt scrap the dung. The maximum dung collection capacity is 2740 kg h^{-1}. Power required to operate dung collector is 0.49 kW. The cost of the unit is Rs. 32000.

Tractor Operated Check Basin Former

Tractor operated check basin former scrapes, collects and distributes the collected soil uniformly to form side bunds and cross bunds at regular interval of 6 m in a single pass forming check basins of 2x6 m size with an effective field capacity of 0.15 ha h^{-1}. The cost of the equipment is Rs. 65,000 (approx.) and cost of operation is Rs. 3073 ha^{-1}. The net saving over conventional method is Rs. 1427 ha^{-1} with a time saving of 96% in comparison to manual operation.

Fig. 5 Paddy transplanter

Paddy Transplanter as an Attachment to Four Wheel Drive Tractor

The VST China make Yanji 8 row paddy transplanter can be used as an attachment to 16.41 kW mini tractor. The power from tractor PTO is transmitted to drive the planting mechanism of the transplanter. The four wheels of VST mini tractor can be replaced with front and rear wheels of a transplanter to avoid sinkage in field condition. The height of the gear box and the height of the top link have been increased for more lifting height through hydraulic system. The Effective field capacity of machine ranges 0.188 - 0.288 ha h^{-1} with field efficiency of 52.80 - 60.50% respectively.

Solar Powered Knapsack Sprayer (3 nozzle)

A solar PV (20 W) knapsack sprayer having three hallow cone nozzles has been developed for spraying in field and vegetable crops. The developed sprayer has been operated by a dc motor to develop the pressure for praying by the three nozzles over the swath width of 1050 mm. During field testing it has resulted particle size variation from 5-50 micron by adjusting the pressure of nozzles through a valve for spraying on different canopy of field and vegetable crops and field capacity of 0.3 ha h^{-1} as compared to conventional knapsack sprayer 0.11 ha h^{-1}.

ISSN : 2279-0454
July - September, 2019

4

INSECT PEST COMPLEX OF TWO QUICK GROWING HOST PLANTS OF LAC INSECT, *FLEMINGLA MACROPHYLLA* AND *FLEMINGLA SEMIALATA* IN MANIPUR CONDITION

K. I. Singh, Ch. Niranjan and Rustam Ngangom
College of Agriculture, Central Agricultural University, Imphal, Manipur
Email: oustam.ngangom@gmail.com

The lac insects *(Kerria* spp., Hemiptera: Tachardiidae) are scale insects which occur naturally as parasites on various host plants. They produce lac, a layer of red resin on branches of host-trees on which they settle. Lac resin is natural, biodegradable and non-toxic, and thus widely used in food, textiles and pharmaceutical industries in addition to surface coating, electrical component manufacturing, and other fields. India is the largest producer of lac in the world and Jharkhand is the leading state, producing about 58% of the total, followed by Chhattisgarh (16%), Madhya Pradesh (12%), Maharashtra (6%), Odisha (6%) and West Bengal (3%). These states has the maximum traditional lac host plants, but the populations of above traditional lac host plants have considerably declined due to rampant deforestation and their poor management in the last three decades. Though, the establishment of new plantations of these traditional lac hosts species is very difficult due to their slow growth and social un-acceptance. Additionally, crop management, lac cultural operations, lac crop protection and harvesting is very difficult in these traditional lac host plants due to their tall height and big crown development. Hence, the lac cultivation and lac production can be increased only by adoption of new fast growing hosts which has a low gestation period such as *Flemingia semialata* Roxb. and *Flemingia macrophylla* (Willd.). with scientific approaches. These both the species of *Flemingia* are grown for lac cultivation and they are emerged as important lac hosts in the country. Both the species attain very short height and can be used for the purpose of intercropping with different crops to earn additional income. These species can be grown in soil having a medium fertility, partial sloppy land with degraded soil of low fertility and slightly acidic soils. Farmers start getting benefits in extremely short time as lac inoculation is possible on one year old plants. Additionally, nitrogen fixing and the soil conservation ability of both the species make them

Fig. 1 Lac insects (*Kerria* spp., Hemiptera: Tachardiidae)

more suitable for cultivation. However, the growth and productivity of these plants are adversely affected by several biotic and abiotic factors. Among the biotic factors, insect pests are the major factors that adversely affected the growth and development of plants in various stages of plant growth that indirectly or directly affects the cultivation of lac insect. Keeping in view of the above constraints, present investigation was carried out with the objective of getting acquaintance with the different insect pests attacking *Flemimgia* spp. under

ISSN : 2279-0454
July - September, 2019

Manipur condition to formulate the suitable preventive measures.

Insect Pests Complex of *Flemimgia* spp.

A total of seven insect pests were recorded during the study on *Flemingia macrophylla* and *Flemingia semialata* plants of which 2 belonged to Hemiptera order, 3 to Lepidoptera order and one each to Coleoptera and Diptera order (Table 1). It was observed that the pest species infested different parts *viz*., leaves, stems, pod/seed of this legume plant but most of the insects were foliage feeders. Major pests which caused significant damage were *Aristobia approximator* and *Archips* sp. Details pertaining to insect pests, plant parts infested and period of activities done are given as under.

Foliage Feeding Pests

***Orgyia* sp. (Lepidoptera: Lymantriidae) - Yellow tussock moth**

Larvae feed on soft young leaves of the plant of both *Flemingia* sp. Its infestation was noticed in the last week of October and continued up to February. The newly emerged young leaves were the main source of food for the larvae.

***Archips* sp. (Lepidoptera: Totricidae) - Totrix moth**

Larvae of *Archips* sp. were found feeding by typically rolling the leaves from the margin and scraping on the inner content of the rolled leaves. Infestation was noticed during December to February.

***Stauropus alternus* Walker (Lepidoptera: Notodontidae) - Lobster moth caterpillar**

Larvae feed the leaves starting from the outer margin including the veins. The incidence of this insect is very low and infestation was noticed during February to last week of March.

***Aristobia approximator* (Coleoptera: Cerambycidae) - long horned beetle**

This is a highly polyphagous insect in which both the adults and larvae cause damaged to the plant. The early stage grub feeds on the leaves starting from the outer margin. In later stage, it feeds on stems by scraping the plant tissue and makes a hole for egg laying. The infested stem parts dries up and fragile and break itself easily. Infestation was noticed during middle week of August to first week of November.

Sap Sucking Insect

***Aphis craccivora* Koch (Hemiptera: Aphididae)**

Among the sucking pest *Aphis craccivora* was recorded as major pest on both the *Flemingia* sp. Both nymphs and adults were found to suck the cell sap from lower surface of the leaves and terminal portion of shoots. The infestation was noticed during 1st week of December to March.

***Plannococcus* sp. (Hemiptera: Pseudococcidae) - Mealy bug**

Mealy bug was observed during February to April only under shade net. They sucked the sap from the leaves and stems of the plant causing yellow coloured damaged symptom. Nymphs feed on underside of the leaves, causing heavy damage to nursery and grown up plants.

***Melanogromyza* sp. (Diptera: Agromyzidae) – Red gram pod fly**

The pod fly was observed during January to March. The larvae bore inside the pod without showing any external symptoms until the fully grown larvae chew the pod wall, leaving a thin papery membrane intact called as window through which adults exit the pods.

Table 1 Insect pests of *Flemingia* sp.

Sl. No.	Pest	Common Name	Order	Family	Damaging stage	Plant parts affected
1.	*Aphis craccivora*	Cow pea aphid	Hemiptera	Aphididae	Nymph & Adult	Suck the cell sap of leaves and stem
2.	*Orgyia* sp.	Yellow tussock moth	Lepidoptera	Lymantriidae	Larva	Leaves
3.	*Aristobia approximator*	Long horned beetle	Coleoptera	Cerambycidae	Adult & larva	Leaves & stem
4.	*Archips* sp.	Tortrix moth	Lepidoptera	Tortricidae	Larva	Leaves
5.	*Stauropus alternus*	Lobster moth	Lepidoptera	Notodontidae	Larva	Leaves
6.	*Plannococcus* sp.	Mealy bug	Hemiptera	Pseudococcidae	Nymph & Adult	Leaves & stem
7.	*Melanogromyza* sp.	Red gram pod fly	Diptera	Agromyzidae	Larvae	Pod

ISSN : 2279-0454
July - September, 2019

Insect Pests Complex of *Flemingia macrophylla* and *Flemingia semialata* (Figs. 2 to 8)

Fig. 2 Lobster moth caterpillar

Fig. 3 Cow pea aphid

Fig. 4 Tortrix moth caterpillar

Fig. 5 Long horned beetle

Fig. 6 Yellow tussock moth

Fig. 7 Mealy bug

Fig. 8 Red gram pod fly

ISSN : 2279-0454
July - September, 2019

5

INTRODUCTION OF COCONUT BASED FARMING IN ARUNACHAL PRADESH

B. N. Hazarika
College of Agriculture, Central Agricultural University, Pasighat, Arunachl Pradesh
Email: bnhazarika13@yahoo.co.in

Foothills of Arunachal Pradesh is having suitable climatic for coconut based farming. However, there is little attention in this direction and other than one or two plants in a very few homestead garden, plantation of coconut is rarely seen in Arunachal Pradesh even in foothills. Therefore, an effort for popularizing coconut cultivation in suitable areas of Arunachal Pradesh is being made by me with establishing a model coconut based farming in college farm of College of Agriculture, CAU, Pasighat. Initially 110 coconut seedling of '*Kamrupa*' variety was collected from Horticultural Research Station, AAU, Kahikuchi and planted in square system at a spacing of 7.5m x7.5 m under fenced orchard. In this system 80% of coconut roots are confined within the radius of 2 m only and a lot of space remain which may be utilized for growing other suitable crops. This article aims to describe the plan of coconut based farming suitable for foothills of Arunachal Pradesh.

Coconut Based Intregated Farming

Growing various inter-crops in coconut orchards is an age-old practice. The main purpose of such cropping is for greater utilization of the solar energy, soil moisture and nutrient resources from various depth and also air space. The rooting pattern of crop combinations should also be kept in view while selecting the individual species. AAU, Jorhat has developed a coconut based multi-storeyed crop combinations incorporating cops like banana, pineapple, assam lemon, ginger and turmeric, vegetables, blackpepper as shown in Fig. 1.

The root systems of these crops were found mutually exclusive and did not overlap to any appreciable extent. The practice of growing crops like banana, papaya, pineapple along with coconut is prevalent in the holdings of small farmers. However, the suitability/compatibility of mixed cropping

Fig. 1 Horticultural Research Station, AAU, Kahikuchi

Fig. 2 Coconut based farming

system has mostly been overlooked and as a result, the competition with coconut for soil moisture during stress period, incidence of sunlight, infestation of pests and occurrence of diseases have been observed. The crops selected for mixed - cropping should preferably be shade tolerant, since the incidence of sunlight would be insufficient below the coconut canopy. Among the mixed crops tested, banana is found to be the most important intercrop for coconut garden. It responds to

ISSN : 2279-0454
July - September, 2019

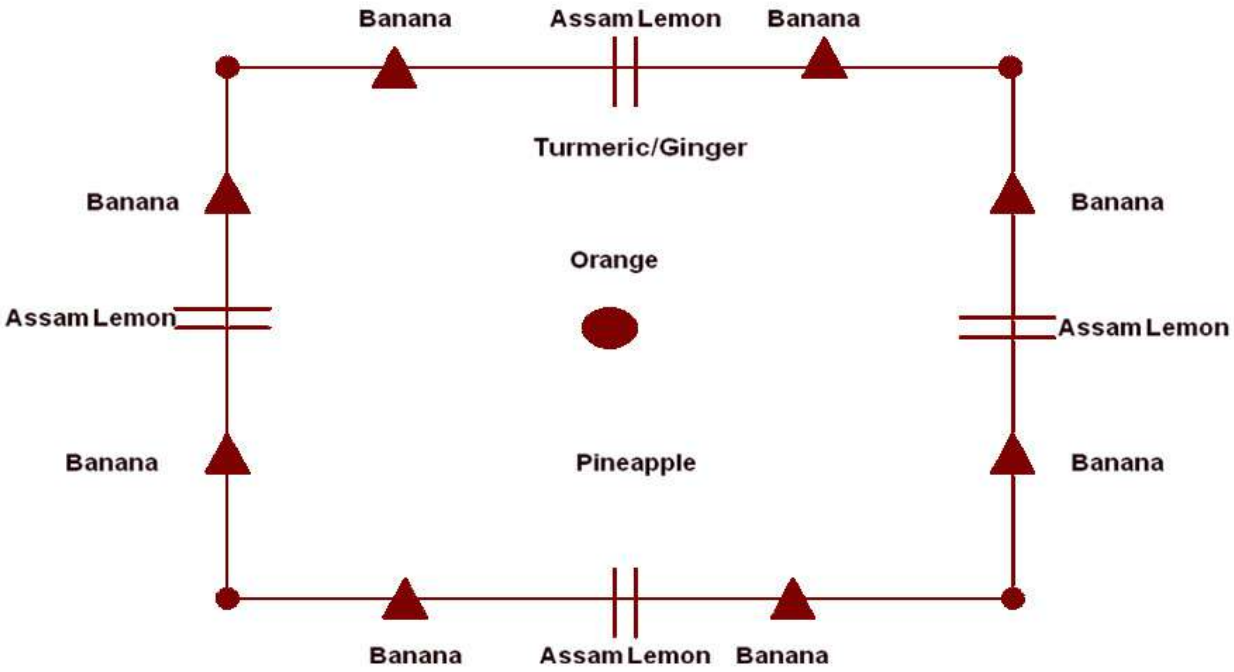


Fig. 3 Coconut based multi-storeyed cropping

similar irrigation and manuring systems as coconut and also comparatively free from serious pests and diseases, except the burrowing nematode in certain pockets. Banana variety Poovan is found suitable in coconut based multi-storeyed cropping.

Fig. 4 Coconut based multi-storeyed cropping at COA, Pasighat

Pineapple could be successfully raised as an intercrop as it can easily be cultivated in semi shade condition and under irrigated condition. About 4000 kg pineapple ha^{-1} can be harvested in multi-storeyed cropping system and much more when only pineapple in grown as inter-crop.

Coconut based mixed farming involves coconut-fodder-livestock farming system which increase employment round the year and also available cow dung can be effectively used by installing a gobar gas plant of 3 m^3 capacity for generating fuel, sufficient to meet the energy needs for lighting and cooking of the farm family and the dairy unit.

Fig. 5 Coconut-fodder-livestock farming

Because of its versatile use the coconut tree is known as the *Kalpabrikha*. Every part of coconut plants can be used in various uses. It also has cultural and religious significance in many societies that use it. It plays a significant role in the agrarian economy of India. Apart from the importance of copra and coconut oil which is widely used in the manufacture of soaps, hair oil, cosmetics and other industrial products, its husk is a source of fiber which supports a sizable coir industry.

Adaptability

Considering the adaptality, foothills of Arunachal Pradesh is highly suitable for growing of coconut as coconut can be cultivated up to 600-900 m above mean sea level with rainfall of 800-2,500 mm y^{-1} is ideal. Mean

ISSN : 2279-0454
July - September, 2019

annual temperature of 27^{0}C with a diurnal variation of 5-7^{0}C is optimum. Low temperature particularly below 15^0 C results in cold injuries to the palms. The humidity should be 82-90%. Laterite, lateritic red, sandy, alluvial sandy, alluvial coastal and black soils are good for coconut cultivation. Moderately deep to deep loamy to clayey, well drain and predominantly acidic with the pH of 4.5-6.8.

Varieties

Kamrupa is a recommended variety for this region developed by AAU, Jorhat which was known as Assam Tall earlier. This variety has the potentialities of producing 106 nut per year by mature palm with copra 16.34 kg per tree, oil content 64.40%, coconut water 253 ml. *Kamrupa* has tolerance to crown rot, bud rot and ganoderma and also can withstand low temperature upto 8^{0}C. It takes 7 years for flowering. Some important cultivars and hybrids recommended now for cultivation are West Coast Tall (WCT), East Coast Tall (ECT), Laccadive Ordinary (LO) (Chandrakalpa), WCT x COD, LO x COD (Chandra Laksha), (ECT x Malaysian Dwarf Green) VHC-1 etc.

Propagation

Coconut is propagated only through seedlings. Selection of seedlings is an important criteria for obtaining quality planting material. Early germinated nuts having a faster rate of leaf production are correlated with early flowering and high nut production. Short stem with good girth at collar, tendency to produce large number of leaves, dark green in colour and early splitting of the leaves are characteristics of quality seedlings which subsequently result in high-yielding palms. Good mother palm can be identified by the following traits:

Fig. 6 Splitting of the coconut leaves

1. Crown should be spherical or semi-spherical, drooping or erect crown should be avoided.
2. Palm should have 30-40 fully opened leaves and 12 to 15 bunches with a high setting of female flowers.
3. Nuts should be medium in size and nearly round or spherical in shape.
4. Palm should be in the age group of 25-50 years.
5. Palms growing close to house, cattle sheds, compost heaps etc. should be avoided.
6. Mother palms selected should be free from pest and diseases.

Cultivation

Planting

The preparation of land for field planting depends upon topography, soil type and water table. In undulating and slopy lands, after clearing under growth, soil conservation measures should be adopted to prevent soil erosion. At a spacing of 7.5 m x 7.5 m about 74% of the roots of coconut palm do not go beyond 2 m laterally and 82% of the roots are confined between 30 and 120 cm depth in soil. Thus the active root zone of coconut utilizes only 25% of the available land. In view of this there is a scope for variations in spacing adopted depending on soil type, varieties, inter- and mixed cropping. In square system of planting, a spacing of 7.5 m or 9 m is ideal for tall varieties, accommodating 175 and 124 palms ha^{-1} respectively. Pits of 1 m x 1 m x 1 m size are prepared during summer months. The pits are filled up to 0.25-0.3 m depth with a mixture of top soil, sand and wood-ash. A small pit to accommodate the nut portion of the seedling is deepened in the filled up portion of the pit. The seedlings are planted at the centre of pits. The soil around the pit is firmly pressed. Care should be taken to see that the collar of the seedling is not covered by the soil. Suitable supports are given so that the roots are not affected by wind. The planting season varies from place to place. However, most appropriate time of planting is during the beginning of the monsoon period (May-June) and October- November in the lowlying areas.

Manuring and fertilization

Coconut palms should be manured from the first year of planting itself. The productivity of coconut is adversely affected if its palms are not fed properly in the beginning. A dose of 0.5 kg N, 0.32 kg P_2O_5 and 1.2 kg K_2O y^{-1} is optimum for an adult palm. The first dose of fertilizer should be applied 3 months after planting. The doses should be gradually increased. The full dose of fertilizer is applied from fourth year onwards.

ISSN : 2279-0454
July - September, 2019

The fertilizer should be applied under optimum soil moisture condition. The one-third dose of fertilizer is applied immediately after the onset of south-east monsoon and the remaining dose at the end of the monsoon. A shallow trench of 1.8 m radius around the base of coconut is made. One-third of the fertilizer dose is applied around the basin covered with organic manure and soil. Basin cultivation of green manure crops like *Calopogonium* and *Mimosa imvisa* during the monsoon season can generate up to 20 kg green manure which can be incorporated in to basin before flowering.

Irrigation

Moisture stress increases leaf fall, lowers growth rate of reproduction. The size of nut and copra content are also reduced due to moisture stress. The irrigation requirement in coconut depends on amount of rainfall, its distribution, soil characteristics, climatic conditions, annual temperature, relative humidity. Drip irrigation economizes use of water, besides improving the water used efficiency. Mulching with coconut husk, coir dust, green leaves and dry coconut leaves not only improves water retention capacity but also reduces the soil erosion hazards. It helps in controlling weeds apart from.

Harvesting and yield

On an average, a tall variety yielding 60-80 nuts palm^{-1} y^{-1} is considered ideal. On an average, coconut yields 44 nuts palm^{-1} y^{-1}. Apart from coconut the yield of different crops grown under integrated farming system can boost the economy of growers.

ISSN : 2279-0454
July - September, 2019

6

MUSHROOM CULTIVATION AS ALTERNATIVE FARMING FOR DOUBLE INCOME OF THE FARMERS IN NORTH-EAST INDIA

Daya Ram and M. Deepa Devi
College of Agriculture, Central Agricultural Univeristy, Imphal, Manipur
Email: d.dram@rediffmail.com

The seven sister states of North-East India along with Sikkim, present a challenge to the researchers as well as the planners when it comes to developing and selecting agro-based programmes for the economic development and socio-economic security of the poor masses. Wide variations in the demography and physiographic cause further exasperations. In the current world of the free market economy, one cannot force the private sector to open industries in this otherwise terrain-hostile region. The government too are slowly reducing their role as public entrepreneurs. It is the agro-based ventures and enterprises, which can transform the scenario. Keeping in view the difficult terrain, ethnic groups with predominant tribal population, and above all the climate, mushroom production is an option with rich potential.

The NE states, located between 22°N-29.5°N and 89.7°E - 97.3°E in India, have a population of about 4.5 crores (current estimate over 2001 Census + 2% annual growth) very thinly spread in an area of 2.55 lakhs sq. km. The region is not easily accessible by normal surface or water transport, which is one of the reasons which inhibit the rapid economic development of this region. Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura constitute the so-called NE, but for developmental programmes, Sikkim has also been added. As industries are almost non-existent and agriculture is of subsistence in kind in most parts, unemployment and underemployment prevails in the vision. Any program for economic development of this region might take into account the profitability of the venture, employment generation, suitability of the climate and liking of the people. A low volume-high value commodity venture like mushroom production is perhaps a highly suitable agro-industrial venture. It is not only highly profitable but is also labour-intensive, and above all not dependent on arable land. Mushrooms are grown indoors and rooms or huts can be raised on otherwise idle land such as slopes. The venture, being indoor, is highly suited to womenfolk. Being highly profitable and labour intensive, it can attract the youth. Unlike in rest of India, mushrooms are not alien to the NE hills. In short, the market for mushrooms in the NE hills is readymade. All the neighbouring countries except perhaps Bangladesh are also very good markets for the mushrooms.

Why Mushroom Cultivation ?

- Mushroom cultivation has become a small-scale agriculture alternative farming for many in North-East India
- Suitable climatic condition
- Does not require access to agricultural land
- Indoor farming
- Income generation
- Profitable venture
- Viable activity
- Nutrition enhancement
- Medicinal value

Though many types of mushrooms are being commercially produced everywhere, the button mushroom (*Agaricus bisporus*), Oyster (*Pleurotus* spp.), Paddy straw mushroom (*Volvariella volvacea*), milky mushroom (*Calocybe indica*) are the most popular with the growers and consumers in India. Shiitake (*Lentinula edodes*) is produced and collected only from the NE in India. The above mentioned mushrooms require different climate regimes specially the temperature, and therefore, can be grown in various regions and

ISSN : 2279-0454
July - September, 2019

seasons in the NE. To illustrate the point further, button mushroom should be grown during the winters or in the hilly regions when the temperature is between 13-19°C which should be followed by the oyster mushroom when it is between 20-30°C, and paddy straw mushroom (28-35°C). Milky mushroom are suitable when it is hottest (30-40°C). In this way a crop rotation of mushrooms in the NE Region can be designed for different regions with a view to providing gainful employment throughout the year.

Different Types of Mushrooms in North-East India (Figs. 1 to 9)

Fig. 1 Morel mushroom

Fig. 2 Shiitake mushroom (*Lentinula edodes*)

Fig. 3 Enoki mushroom

Fig. 4 Oyster mushroom (*Pleurotus* spp.)

Fig. 5 Maitake mushroom

Fig. 6 Reishi mushroom

Fig. 7 Button mushroom (*Agaricus bisporus*)

Fig. 8 Paddy straw mushroom (*Volvariella volvacea*)

ISSN : 2279-0454
July - September, 2019

Fig. 9 Milky mushroom (*Calocybe indica*)

Advantage of Mushroom Cultivation in NE India

1. Varied climate (5-35°C) suitable for all mushrooms
2. Abundant agro-wastes (raw materials)
3. Excellent domestic (local) market
4. Mushrooms as food are very popular with the NE people
5. High humidity (always above 60%)
6. Access to the market in the neighbouring countries (like China, Myanmar, and others can be attempted).

Suggestions to Enhance Mushroom Cultivation

- Suitable machineries for mushroom production should be developed indigenously at reasonable cost in the country.
- Establish good linkage between mushroom industry and R&D establishments.
- Value added products of mushrooms should be popularized.
- Interaction with government officials, entrepreneurs, farmers, marketing agencies and processing industries can help in realizing the potential of the venture to provide unique solutions to handle the problems of poverty, unemployment and malnutrition prevalent in the region.
- An integrated approach, missionary zeal and concerted efforts by various public institutions, departments and NGOs are of paramount importance to make the NE a mushroom bowl of the country.

A Success Story of Manipur

- **Name of the farmer: Mr. Birendra Singh**
- Location- Bishnupur District
- Started - March 2019
- Private Venture

Mr. Birendra Singh from Bishnupur District of Manipur participated in the three months Skill Development Programme on Mushroom cultivation was conducted by the Department of Plant Pathology, College of Agriculture, Central Agricultural University, Imphal during October 8, 2018 to January 8, 2018.

Fig. 10 Spawn preparation

Fig. 11 Soaking of paddy straw

Fig. 12 Packing of paddy stray inside polythene bags

Fig. 13 Storage at lower room temperature

After successful completion of the hands on training programme (Figs. 10 to 13), he started his private venture during March 2019. All family members are involved in this venture. The farm consists of 10-12 workers. He gets a harvest of about 12-13 kg mushroom per day at the cost of Rs. 200 kg^{-1}. His monthly profit is Rs. 50,000-60,000 approximately.

Fig. 14 Mr. Birendra Singh

Fig. 15 Mushroom Unit of Mr. Singh

ISSN : 2279-0454
July - September, 2019

7

APPLICATION OF COMPOSITE MATERIALS FOR MANUFACTURING COMPONENTS OF IMPROVED EQUIPMENTS - A REVIEW

Jekender Yumnam[1], R. K. Tiwari[2], S. K. Chauan[3] and M. Din[2]
[1]*College of Food Technology, CAU, Imphal, Manipur*
[2] *Central Institute of Agricultural Engineering, Bhopal, Madhya pradesh*
[3] *CAEPHT, CAU, Ranipool, Sikkim*
Email: rk96tiwari@gmail.com

The population of draught animals is 49.69 million among which population of bullock is 44.48 million, buffaloes 4.09 million and 1.12 million other important draught animals namely camel, equines, donkey, horse, pony, mule, yak and mithun. The equivalent animal power available has been estimated to be 12.14 Million kW from 48.57 million bovines. The DAP although has potential to generate annually 21852 million kWh energy (at 1800 working hours per year) but due to declining use (350 working hour/year) the power availability has been limited to 4249 million kWh.

Organic farming is coming up in a big way in the country. At present about 90% of the registered farmers adopting organic farming has been from small and marginal farmers having up to 2 ha holdings. These farmers are also the major users of animal energy for cultivation purposes. Therefore, there is a need to develop matching implement for mechanized organic farming.

Yoke of Composite Materials

A Yoke of composite material as a substitute for wood has been developed at GBPUA&T, Pantnagar Centre. It is made of a composite material i.e. resin, silica, glass wool, jute net, bagasse and paddy straw. Bending strength of composite material yoke is 47 N/mm^2 as compared to 13 N/mm^2 in case of wooden yoke. The weight of composite yoke is 2.90 kg, whereas the wooden yoke's weight is 4.88 kg.

Fig. 1 Composite material of Yoke

Fig. 2 Animal drawn planker of composite material

Animal Drawn Planker of Composite Material

GBPUA&T, Pant Nagar centre has developed a light weight planker of composite material for breaking the soil clods, land levelling and grading purpose. The composite material planker has been moulded with the dimensions of 122×25×10 cm. An extruded section is provided at the upper surface (non-sliding side) of planker to increase or decrease the weight of the bio-composite planker, with the help of stones and soil in the field as per desired work. Due to light in weight it can be transported easily at hilly terrain. The flexural, tensile and compressive strength of composite material planker is 58, 72 and 40% higher than the conventional wood planker. The calculated cost of the bio-composite planker was Rs. 2070, which is less as compared to wooden planker. Farmers liked the planker and beam of composite material and have shown keen interest for adoption of newly design saddle.

ISSN : 2279-0454
July - September, 2019

Fig. 3 Axial flow thresher for *Coriandrum stavium* L.

Axial Flow thresher for *Coriandrum stavium* L.

The axial flow multi-crop thresher developed for hilly region has been developed and evaluated for threshing of *Coriandrum stavium* L. variety by GBPUAT Centre of AICRP on FIM. The thresher has been evaluated with two combinations i.e., MS cylinder having MS pegs and PVC cylinder having composite pegs. The cylinder peripheral speed of 6 m s^{-1} and cylinder concave clearance of 15 mm gave the best results for PVC cylinder with composite pegs. The threshing efficiency, cleaning efficiency, percentage of broken seed, sieve loss and cylinder loss for threshing of coriandrum crop were 99.80, 91.29, 0.7, 2.07 and 0.21%, respectively. Therefore, PVC cylinder with composite pegs rotated at peripheral speed of 6 m s^{-1} and cylinder concave clearance of 15 mm could be used for threshing of coriander crop. The annual benefit is Rs. 25600 $unit^{-1}$. The equipment is ready for commercialization.

Improved Saddle of Composite Materials for Domesticated Yak

AICRP on Utilization of Animal Energy located at CAEPHT (CAU), Ranipool (Sikkim) in collaboration with GBPUA&T, Pant Nagar Centre (Uttaranchal) has developed an improved saddle of composite materials having weight of 3.2 kg, tensile strength; 24.8 N/mm^2 with unit price of Rs. 1500 for pack load transport of materials in hilly areas using yak. The overall dimensions of composite saddle are 350 x 340 x 230 mm. The improved saddle has been made of composite material which is constituted of resins, hardener, reinforcement element, silica, glass wool, jute net, *bagasse* and paddy straw. It is made by using moulding and casting technique to ensure strength and durability. The test trial of developed improved saddle was performed at Thangu region (Altitudes 4270 - 4800 m) in north Sikkim district during winter. The maximum packload of 120 kg (three bags of potato each of 40 kg weight) on yak could be transported covering 5.5 km distance (travel speed : 2.62 km h^{-1}) in two hour duration at steep up slope of 60 degree. The test result shows that newly developed saddle was able to take 30% more load over traditional saddle. The farmers will get 25% higher profit with using newly developed saddle of composite material. Yak rearing farmers at Sikkim have shown keen interest for adoption of new design of saddle.

Fig. 4 Improved saddle of composite materials for domesticated yak

ISSN : 2279-0454
July - September, 2019

8

ON FARM PRODUCTION OF ENTOMOPATHOGENIC FUNGI

Kennedy Ningthoujam[1], Mareena Sorokhaibam[2], K. Mamocha Singh[2], Yanglem Herojit Singh[3]and Rojeet Thangjam[4]
[1]*College of Post Graduate Studies in Agricultural Sciences, CAU, Umiam, Meghalaya*
[2]*College of Agriculture, CAU, Imphal, Manipur*
[3]*KVK East Garo Hills, Megagre, Meghalaya*
[4]*College of Agriculture, CAU, Kyrdemkulai, Meghalaya*
Email: kennedy1982@gmail.com

Entomopathogenic fungi are often reported as causing high levels of epizootics in nature and are the most versatile biological control agents, and are environmentally safe. An attractive feature of these fungi is that the virulence cause by contact and the action is through penetration. These fungi subsume a heterogeneous group of over 100 genera with approximately 750 species, notified from different insects. Many of these are proved to be highly potential in pest management. The most considerable fungal species are *Metarhizium* spp., *Beauveria* spp., *Nomuraea rileyi*, *Verticillium lecanii* and *Hirsutella* spp. Among them, *Metarhizium* spp. and *Beauveria* spp. were the most widely exploited entomopathogenic fungus in biocontrol. It is known to attack over 200 species of insect belonging to order Coleoptera, Homoptera, Lepidoptera, Dermaptera and Orthoptera.

Mode of Action and Host Reaction (Fig. 1)

The mode of action of insect pathogenic fungi varies and kills the insect by different ways such as causing starvation to toxin production. These insect pathogenic fungi produce many toxins and extracellular enzymes such as proteases and chitinase which aid penetration of the host physical defences. Cuticle is the main hurdle to infection in insects as it is the main path of fungus penetration. Hence, it needs some physical or enzymatic means to pierce the hard cuticle.

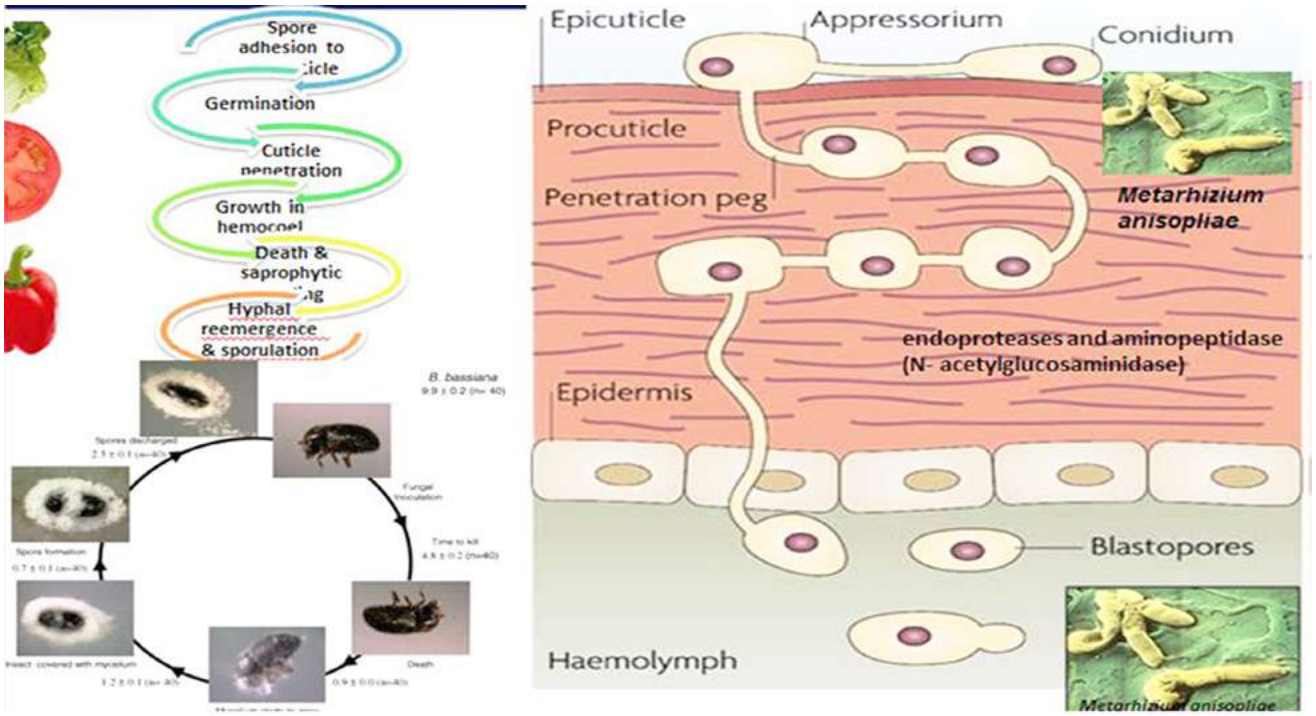


Fig. 1 Mode of action and host reaction

ISSN : 2279-0454
July - September, 2019

The infective unit in most fungi is a spore, usually a conidium. In many cases, the conidia are adhesive to the cuticle, or secrete adhesive mucus as the conidium swells during pre-germination. In favourable conditions, the conidium, germinates into a short germ tube which gives out small swellings called appressoria. The appressorium attaches itself to the cuticle and sends out an infection peg which provides a firm attachment that the fungus needs to physically force its way into the host. The hyphae then penetrate the layers of the integument by enzymatic dissolution of chitin and protein, ramify first in the cuticle and then reach the haemocoel and internal organs. The invasion by the fungal mycelium continues until the insect is virtually filled with the fungus and becomes quite firm to touch. Conidiophores are then produced which erupt through the cuticle and produce spores on the outside of the insect, infecting nearby healthy insects also. Death of the host is by obliteration (choking) of the tissues and also by the toxins produced by the fungus.

Symptoms

Loss of appetite followed by decreased irritability, general or partial paralysis, discoloured patches on integument and increased acidity in the blood. The body hardens and the insect in upright on its legs at the time of death. Death occurs within a week or even within 24 hours. The causes of death may be as follows: hyphae may force apart muscles, blood cells may stop circulating due to increased hyphae, blockage of the gut and by the toxin produced by the fungus.

Fig. 2 *Beauveria* infected aphid

Fig. 3 *Metarhizium* infected grub

Commercial Production of EPF

Most of the commercially produced fungi are species of *Beauveria*, *Metarhizium* and *Lecanicillium* that are relatively easy to mass produce. Attention has focused predominantly on the technical aspects of biopesticide development, such as mass production and formulation, and the selection of strains with rapid kill.

Production requirements include reasonable cost, long-term stability, and, most importantly, consistent efficacy under field conditions. The on farm production of EPF by using grains is simple and cost effective. The production methods are given below:

On-farm Production of Entomopathogenic Fungi on Grains

Material required

a) EPF mother culture

b) Sorghum grains (or any cereals)

c) Polypropylene bags (Autoclavable)

d) PVC pipe

e) Cotton plugs

f) Pressure cooker

g) Wooden chamber

h) Spirit lamp

i) Plastic trays

Production technology

Sterilization of grains

1. Take 100 g of grains (sorghum or any cereals) in an autoclavable polypropylene bag and add 100 ml of water (1:1 ratio)
2. Fix a 1.5" PVC pipe at the top of the bag with a rubber band
3. Close the PVC pipe using a cotton plug
4. Keep the bags in a pressure cooker in an upright position and cook for 40 minutes
5. Take out the sterilized bags from the pressure cooker and keep them to cool down to reach room temperature

Inoculation with EPF mother culture

1. Before the inoculation sterilize the wooden chamber using spirit
2. Lit a spirit lamp in the wooden chamber

ISSN : 2279-0454
July - September, 2019

3. Take the sterilized grains into the wooden chamber and open the cotton plug in front of spirit lamp
4. Transfer the mother culture into the bags from the PVC pipe
5. After inoculation close the PVC pipe with cotton plug

Incubation

1. After inoculation take the bags from the wooden chamber and shake the bags for a proper mixing of EPF mother culture with grains
2. Keep the bags in a dry place outreach of sunlight at room temperature
3. Shake the bags at least three times a day
4. After three days of inoculation white mycelial growth will be observed
5. And after seven days of inoculation we can observe the sporulation of inoculated mother culture

Drying

1. After the incubation take the grains in a plastic tray (sterilized with spirit)
2. Close the tray using a newspaper and tie a rubber band
3. When the grains get dried up take the grains in a mixture grinder and make them a fine powder

Use of EPF in Pest Management

EPF are a major component of integrated pest management techniques as biological control agents against insect pests and other arthropods and are an integral part of myco-insecticides in horticulture, forestry and agriculture.

Some of the commonly used EPF are as follows.

1. *Beauveria bassiana* – These enter the host insects body through food or in contact with the host cuticle and reproduce inside the insect body. It produces toxins namely beauvericin, bassianocide etc. inside the host body causes paralysis of the host insects and ultimately kills the insects within four or five days. They are used particularly to control sucking pests and caterpillars infesting crop plants. These fungi are used to control the caterpillars of yellow stem borer and leaf folder of rice, white grub of groundnut, sugarcane pyrilla, coconut rhinoceros beetle, caterpillars of pulses, tomato and cotton, diamond back moth, leaf eating caterpillars of tobacco and sunflower etc.
2. *Lecanicelium lecanii* – This beneficial fungus is mainly used to control whiteflies, aphids, thrips, brown plant hopper, scale insects, mealy bugs and other sucking insect pests of crop plants.
3. *Metarrhizium anisopliae* – This pathogenic fungus is used to control mainly coconut rhinoceros beetle, groundnut cut worm, rice brown plant hopper, diamond back moth and early shoot borer, top shoot borer and internode borer of sugarcane.
4. *Nomuraea rileyi* – It is used to control pod borers, cut worms, cabbage borers etc.
5. *Hirsutella thompsonii* – These fungi are used to control different hoppers and bug pests, whiteflies, red mites etc.
6. *Paecelomyces fumosoroseus* – This fungus is used to control yellow and red mite, whiteflies etc.

Field Dosage

Soil application of *Metarrhizium anisopliae* @ 5×10^{13} conidia ha^{-1} for soil pests.

Foliar application of *Beauveria bassiana* @ 1×10^{7} spores ml^{-1} + 0.05% teepol for foliar pests.

ISSN : 2279-0454
July - September, 2019

MULTISTORIED CROPPING SYSTEM- A SUSTAINABLE LAND USE APPROACH FOR NORTH-EASTERN STATES

Abhimanyu Chaturvedi and D. S. Chonkar
Krishi Vigyan Kendra Tirap, Deomali, Arunachal Pradesh
Email: mannuhorti@gmail.com

A multi-storied approach system is often viewed as a sustainable alternative farming system particularly on small and marginal lands and it can provide greater economic return per unit area. Land cultivation through this system can maintain sustainable ecological balance besides efficient use of all natural resources.

Agriculture/Horticulture/ Silviculture based cropping systems especially Horti-Horti and Horti-Agri based cropping system plays a potential role in realizing more sustainable productivity and income.

Growing of intercrops, mixed crops, multiple crops and multistoried crops in perennial fruits (Mango, Litchi, Banana etc.) and plantation crops (Coconut, Areca nut, Coffee etc.) produces more food products, ensuring sustainable income besides employment generation.

The system is more adaptable in tall growing perennials with compatible semi-perennial and annual crops. The practice of multi storied cropping system is highly successful in plantation crops especially in Coconut, Areca nut, Coffee and Cashew for enhancing sustainable productivity and realizing higher income per unit area.

Principles

- Intensification of agricultural land use has led to the development of multi-storied cropping system and crop mixtures.
- The introduction of multi-storied cropping system ensures the use of best combination of crop-tree intercropping to reduce the impacts of floods, landslides and droughts.
- Also, it ensures a regular income and employment throughout the year from harvest of different tree crops in different seasons.
- This system accommodates crops of different heights, canopy patterns and rooting systems to maximize the sunlight, nutrients and sustainable land use.
- Ecological balance and judicious and efficient use of all natural resources are the key points. In addition to this, multi-storied cropping systems are more amicable for horticultural crops as they include tree species, shrubs, climbers, annuals and shade loving or tolerant species.
- This system is highly successful in plantation crops especially in Coconut, Areca nut etc for enhancing sustainable productivity and realizing higher income per unit area.

Feasibility of Multi Storied Cropping System in Horticultural Crops

- Horticultural crops especially fruits and plantation crops are perennial in nature and long pre-bearing period (Mango, Coconut, Areca nut, Cashew).
- Crops have wider spacing and are tall growing eg: Coconut (7.5x7.5 m, 15- 20 m ht.), Areca nut (2.7x2.7m, 15-20 m ht.).
- Canopy cover (Occupation of space) is very slow, took years together and more than 60-70% inter space is not effectively utilized (Mango, Coconut, Areca nut).
- Crop geometry and rooting pattern among perennials, semi-perennials and annual crops could be compatible without any adverse effect on main crops (Arecanut, Cocoa, Banana, Ginger, Turmeric and Pineapple).
- Crops are shade loving and tolerance to dripping of rain drops and high humidity (Banana, Cocoa, Turmeric, Ginger, Pineapple and Pepper).

ISSN : 2279-0454
July - September, 2019

- Crops are the good source of bio-mass and byproducts which are easily recyclable and decomposable (Coconut, Areca nut, Tree spices, Turmeric, Ginger, Guava).
- Crops having different harvesting time and period which facilitates for sustainable income (Banana, Areca nut, Pineapple, Ginger and Turmeric).
- Suitability / tolerance to prevailing micro – climatic condition (Black pepper, Pineapple, Tree spices, Marigold).

Table 1 List of fruit crop based system with their intercrops (Horti-Agri System)

S. No.	Crop	Main crop with intecrop
1	Mandarin	Mandarin + Ginger, Mandarin + Pea
2	Assam Lemon	Assam Lemon + French bean
3	Banana	Banana + Sweet Potato
4	Arecanut	Arecanut + Black pepper + Tea Arecanut +Black pepper + Ginger Arecanut + Black pepper + Turmeric Arecanut + Black pepper + Tapioca

Structure of Multi-Layer Cropping System

- Perennial crops (Arecanut, Coconut, Pineapple) and annuals/biennials (Root Crops: Taro, Yam, Sweet Potato etc.) are inter planted to maximize productivity and income.
- This is most applicable where farms are small and the system needs to be intensive.
- In this particular area, Arecanut, Coconuts are usually planted first. When they reach a height of 4.5 m (after 3-4 years), bananas, papaya are planted underneath. Black pepper may also be part of the system. After sufficient space, has developed at ground level in about three to four years, root crops are planted. At full establishment, the system develops different layers: Arecanut (tallest) followed by banana, papaya (middle), root crops and pineapple (lowest).

Conclusion

- Multi-tier cropping system involved combination of plants with various morpho-phenological features to maximize the natural resource use efficiency and enhanced total factor productivity.
- Horticulture crops particularly fruit and plantation crops have self-sustainable system where solar energy can be harvested at different heights, soil resources are used efficiently and can increase cropping intensities.
- The system consists of three main components *viz.*, main crops, filler crop and intercrops which occupy three different tiers in space of the production system.
- To ensure sustainable productivity and high returns from underutilized and stressed lands and to improve the soil characteristics multi-storey cropping system have been found successful in tropical rain forest. Multi stored cropping system in horticulture is found to be a perspective approach for sustainable productivity in fruit crops (Mango, Litchi, Amla) and Plantation crops (Coconut, Areca nut, Coffee, Cashew) by which natural resources are utilized efficiently to enhance productivity of main crops (15-20%) and high revenue realization per unit area (50-90%).

ISSN : 2279-0454
July - September, 2019

10

ON FARM PRODUCTION OF MYCORRHIZAE

Yanglem Herojit Singh[1], K. Mamocha Singh[2], Kennedy Ningthoujam[3] and Ng. Taibangnganbi Chanu[4]
[1]*KVK, CAU, East Garo Hills, Megagre, Meghalaya*
[2]*College of Agriculture, CAU, Imphal, Manipur*
[3]*College of Post Graduate Studies in Agricultural Sciences, Umiam, Meghalaya*
[4]*College of Horticulture and Forestry, Pasighat, Arunachal Pradesh*
Email: herojityanglem18@gmail.com

Mycorrhiza are symbiotic relationships between fungi and roots of higher plants and such fungus-roots'are called mycorrhizae. Perhaps more than 80% plant species are having mycorrhizal association. The exceptions are many members of the Cruciferae family (e.g., broccoli, mustard), and the Chenopodiaceae family (e.g. lambsquarters, spinach, beets), which do not form mycorrhizal associations. The level of dependency on mycorrhizae varies greatly among varieties of some crops, including wheat and corn. Mycorrhizae increases the root's ability to absorb the nutrients (phosphorus (P), zinc (Zn), manganese (Mn), copper (Cu)) and water from the soil by increasing the surface absorbing area of roots from 100 to 1,000 times.

All the cultivated plants remove large quantity of nutrients from soil, particularly NPK. Among these major nutrients, the efficiency of applied P through chemical fertilizers is very low i.e., 15 to 20%. This is due to fixation of applied phosphorous in the soil into unavailable form. Therefore, there is need to enhance the phosphorous availability by using phosphorous solubilising microorganisms (PSM). Among PSM, different species of mycorrhizal fungi have been reported to be effective in increasing growth and uptake of phosphorous by different plant species. Mycorrhiza filaments extend from the roots into the soil, reaching several times beyond the root hairs. Nutrients are taken up by the hyphae and carried to the plant.

Types of Mycorrhizae

On the basis of morphological and anatomical features, mycorrhizae are divided into three types:

a) Endomycorrhizae

b) Ectomycorrhizae

c) Ectendomycorrhizae

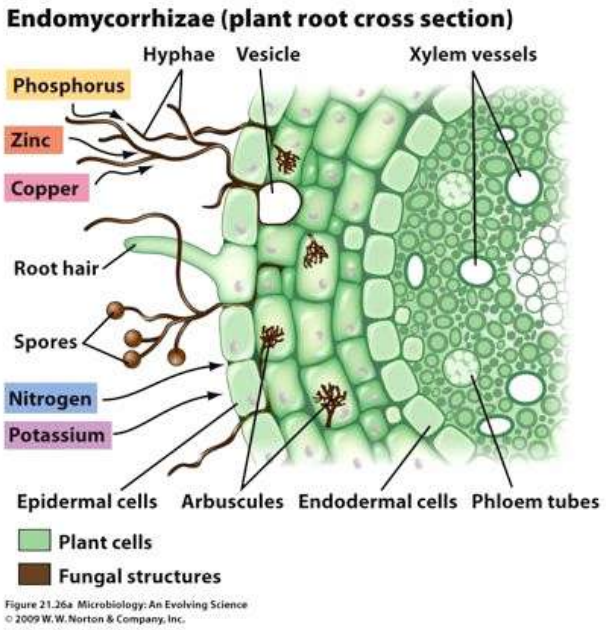


Fig. 1 Endomycorrhizae-plant root cross section

Endomycorrhizae

It is a mycorrhizal association in which the fungal hyphae are present on root surface as individual threads that may penetrate directly into root hairs, other epidermal cells and into cortical cells.

Endomycorrhizae further classified into five types:

i. VAM fungi (vesicular arbuscular mycorrhizae)

ii. Orchidoid mycorrhizae

iii. Monotropoid mycorrhizae

iv. Ericoid Mycorrhizae

v. Arbutoid mycorrhizae

ISSN : 2279-0454
July - September, 2019

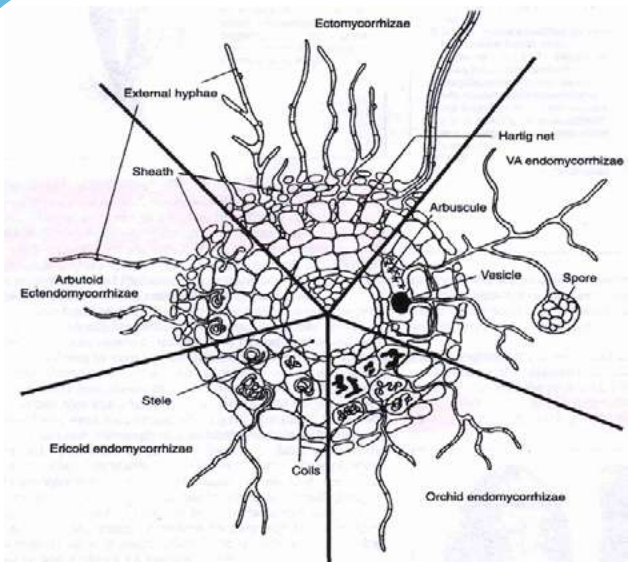


Fig. 2 Different types of endomycorrhiza

VAM fungi (Vesicular Arbuscule mycorrhizae)

- Fungi formed VAM association with plants may belong to zygomycetes.
- All VAM fungi are obligate biotrophic, as they are completely dependent on plants for their survival.
- Some of the fungi forming Endomycorrhizae are Endogone, Glomus, Sclerocystis, Gigaspora etc.

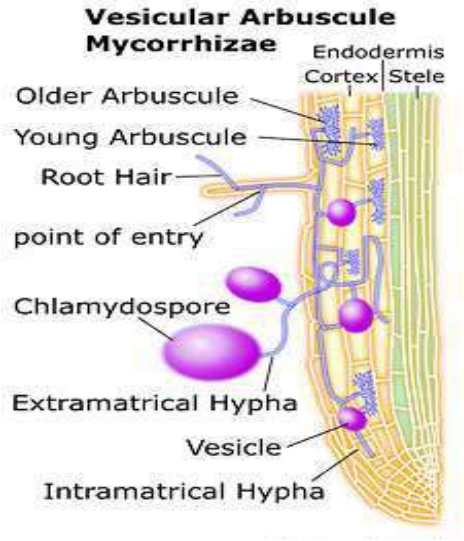


Fig. 3 VAM

Ectomycorrhizae

- Ectomycorrhizae (ECM) are association, where fungi form a mantle around roots.
- There is no hyphal penetration of cells.
- Fungal hypha is generally separate.
- A distinct Hartig's net is present between the cells

Ectendomycorrhizae

The fungi belong to Basidiomycotina, which covers both gymnosperms and Angiosperms plants. Ectendomycorrhizae show many of the same characteristics' of Endomycorrhizae but also show extensive intercellular penetration.

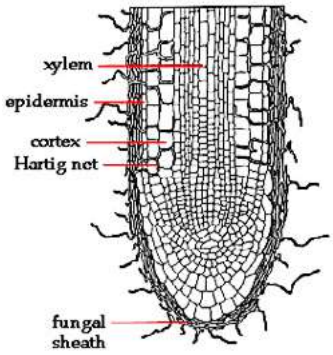


Fig. 4 Ectomycorrhizae

Mass Production

Obligate symbionts AM fungi could be mass produced only in the presence of living roots. There are several techniques reported for mass production of AM inoculums.

Aim of "On Farm Production Technique"

- To ensure high quality AM inoculums in large quantities at farmers field
- Very little cost technology.

Method of Mycorrhiza production

a) **Pit method (Fig. 5)**

- A nursery area of about 75 m^2 (5 m × 15 m) is selected and split into 3 beds of equal sizes (0.8 m × 15 m).

Key points in procedure

- Development of mycorrhizal starter culture prepared by either isolating resident AM fungi or by procuring commercial starter culture.
- Multiplying the culture on trap plant roots at farmers' fields.

Steps involved

Selection of site

- The site should be water logging free, leveled.
- Low in available phosphorous.
- The site is prepared by ploughing and hoeing to make raised beds (80 cm wide, 20 cm high and 15 m length) with a spacing of 0.6-0.8 m between rows.
- The soil in these beds needs to be amended with well decomposed compost/ vermicompost @ 4 kg m^{-1} or fine powdered FYM @ 8 kg m^{-1}.

ISSN : 2279-0454
July - September, 2019

AM fungal inoculation

- AM fungal inoculum (@ 8,000 infective propagules m^{-2}) is placed 2-3 cm deep in furrows just below the seed at the time of seed sowing.
- Direct seeded crops like methi, maize, sorghum, marigold, barseem etc., can be used as trap plants.
- Transplanted crops like tomato, brinjal, onion etc., can also be used as trap plants in between routine multiplication cycles.

Multiplication

- The multiplication of AM fungi generally coincides with the host cycle comprising of *kharif, rabi* and summer cropping seasons.
- Regular hoeing, weeding, watering, and protection from animals should be done during the multiplication cycles.
- There should not be any water logging in the nursery beds especially during rainy season.

Harvesting of inoculum

- At the end of each cycle, the shoot of the trap plants are removed from the soil surface without disturbing the roots, the roots need to be retained in the beds but the soil should be hoed or loosened during second cycle of multiplication and so on.
- After 5 multiplication cycles the plants are uprooted gently to get maximum root biomass.
- The roots with adhering soil are then chopped finely and thoroughly mixed.
- This mixture is tested for percent root length mycorrhizal colonization and analyzed for number of infectious propagules (IP) per g inoculum using standard protocols

Fig. 5 Pit Method

b) Pot method (Fig. 6)

Methodology

- Take required quantity of soil from own field to fill up the pots. Sterilize soil to minimize the presence of other fungus or pathogens in soil by heating for 2-4 h using a big metal pan or by drying under intense heat of the sun for 2-3 days.
- After cooling, place the sterilized soil in thoroughly cleaned dry pots. For large scale production polythene bags, trough lined with plastic sheet may be used.
- Place a pinch of root mother culture in the pot and then cover with a thin layer of soil.
- Sow 3-5 seeds in each pot at such a depth that seedling roots should come in contact with culture`.
- Grow the plants for three months under normal conditions.
- Stop watering the plants after 3 months and cut the upper part of plants or stalks when they are completely dried. Allow the soil in the pot to dry further.
- Remove the roots along with adhering soil from the pots and dry in shade.
- Cut the roots finely and save some root inoculants for future use. Mix the fine cut roots with the soil from the pot to produce VAM soil culture.
- Store the root and soil inoculants in sealed plastic bags in cool dry place.

Fig. 6 Pot Method

Precautions for Production of Mycorrhiza

- Compulsory use quality Mycorrhiza mother culture for production (100 infective propagules per g)
- Create physical contact between the mycorrhizal culture and the plant root
- Care should be taken during plants grow

Benefited Crops

Mycorrhiza or VAM suitable for all cereals, legumes, fruits and horticultural crops

Benefits of Mycorrhiza

- Produce more vigorous and healthy plants. Increase

ISSN : 2279-0454
July - September, 2019

plant establishment and survival at seedling or transplanting.

- Enhance flowering and fruiting.
- Increase yields and crop quality.
- Improve drought tolerance, allowing watering reduction
- Optimize fertilizers use, especially phosphorus.
- Increase tolerance to soil salinity.
- Reduce disease occurrence.
- Contribute to maintain soil quality and nutrient cycling.
- Contribute to control soil erosion.

Application of VAM Fungi

Nursery application

- 100 g bulk inoculum is sufficient for one m^2.
- The inoculum should be applied a 2-3 cm below the soil at the time of sowing.
- The seeds/cuttings should be sown/planted above the VAM inoculum to cause infection.

For polythene bag raised crops

- 5 to 10 g bulk inoculum is sufficient for each packet.
- Mix 1 kg of inoculum with 100 kg of potting mixture and pack the potting mixture in polythene bag before sowing.

For out-planting

- 20 g of VAM inoculum is required per seedling
- Apply inoculum at the time of planting.

For existing trees

- 200 g VAM inoculum is required for inoculating one tree. Apply inoculum near the root surface at the time of fertilizer application

Application Dose: 3-4 kg $acre^{-1}$

Economics of AMF Production

- In this on-farm production technique, the left over rhizospheric soil (after harvesting of roots) contains fairly good number of infectious propagules (more than 10 IP g^{-1} soil) and can be used to continue subsequent production cycles, to produce 10 lakhs propagules of AM fungi during every cropping season.

Fig. 7 Mycorrhiza moculated plants

- The average cost of production is Rs. 400.00 during each production cycle for producing sufficient inoculum for application in one ha.

Assessment of Root Colonization

- Wash the surface feeder roots and cut the roots up to 1 cm.
- Heat the roots at 70°C for 10-15 min (depend upon the age and tenderness of the roots) with 10% potassium hydroxide (KOH) solution.
- Pour off the KOH solution and rinse the roots thoroughly with water.
- Acidify the roots by immersing in 5% HCl for 5 min.
- Pour out the HCl and add staining solution (0.05% lactophenol tryphan blue) and keep them overnight for staining or boil for 10-15 min at 70°C.
- Destain the roots with destaining solution (50% glycerol).
- Mount the root pieces on the glass slides and observe under microscope for mycorrhizal colonization.

Mycorrhizal colonization is expressed using the following formula:

$$\text{Percentage of Colonization} = \frac{\text{Number of root segments with Mycorrhiza} \times 100}{\text{Total number of roots segments examined}}$$

ISSN : 2279-0454
July - September, 2019

11

CLIMATE-SMART AGRICULTURE: GOOD OPTION FOR CHANGING CLIMATE

Rekha Yadav
Chaudhary Charan Singh Haryana Agricultural University, Hisar
Email: rekha25yadav@gmail.com

According to FAO 'Climate-Smart Agriculture' is an approach that helps to guide actions needed to transform and reorient agricultural systems to support food security under the new realities of climate change. It provides the means to help stakeholders from local to national and international levels to find agricultural strategies which are well suited to their local conditions.

Policies and Planning

Main areas of intervention related to policies and planning for adoption of Climate Smart Agriculture are:

1. Support to countries to ensure that agriculture and Climate Smart Agriculture are included in mid to long term development planning processes and investment decisions.
2. Support to countries in creating the required policy, financial and enabling environment.

Need of Climate Smart Agriculture

Annual temperatures have changed more rapidly in recent years. Huge crop losses occurred due to abnormalities in weather conditions (excessively and untimely rains, hailstorms and strong winds) in different parts of the country and resulted in huge losses to small and marginal farmers. Changes in rainfall pattern due to global warming and increased chances of El Nino have intensified the probabilities of crop failure. The crisis management plan of the Government of India (2012) reported that annually 50 million people are exposed to chronic drought. Thirty three percent of land receives less than 750 mm of rainfall and is classified under chronically drought prone area. Rainfall is erratic in 4 out of 10 years. As per Government of India (2012) estimate, 5700 km^2 of coastal area in India will be lost due to 1 m sea level rise which will result in displacing the people and will result in significant economic losses.

The UN conferences on Sustainable Development in 2012, June, Rio, had emphasized that due to fast changing climate, there will be threats to water, food, biodiversity and other critical resources which will intensify the crisis (Economic, Ecological and Social) and therefore, FAO (2012) has emphasized that Green/ Climate Smart Agriculture is required for achieving green economy.

Practices

1. Integrated Practices: Practices where a range of stakeholders are involved will result in greater efficiency in the use of resources and better sustainable management of natural and human created processes. It will also help in reducing pressure on natural resources and less dependency on external inputs like pesticides, chemical fertilizers and energy.
2. Crop production: Crop production must adapt (sustainable cropping pattern, selection of appropriate varieties, ecosystem management approaches, and developing new varieties) and become resilient to changes (frequency and intensity) in order to cope with the challenges developed due to climate change.
3. Livestock: By proper feed management, manure management and enteric fermentation, several alternatives are present to reduce green house gases which can help in climate smart food supply system.
4. Forestry: Supply of goods and services is jeopardized due to climate change which is essential for food security and sustainability of environment.
5. Urban and Peri urban Agriculture: Urban food supply system is under pressure due to rapid growth of urbanization. Agriculture (Horticulture, Livestock, Fisheries, Forestry, Fodder and Milk

ISSN : 2279-0454
July - September, 2019

production) is increasingly moving to cities and towns.

6. Genetic resource and Biodiversity: Availability of wide genetic resource base helps in food security, nutrition, livelihood and sustainable environment.
7. Fisheries and aquaculture: It helps in providing essential nutrition and support livelihood. But due to ocean acidification and climate variability, it is also facing huge challenges.
8. Land and water management: It is one of the key components of Climate Smart Agriculture. Different practices are adopted for sustainable management of land and water which include restoration of degraded and wasteland and soil carbon sequestration.
9. Proactive drought management: Drought has socio economic impacts and agriculture is the most drought affected sector.
10. Energy: Less dependency on non renewable energy sources and in fact production of energy from agricultural system can help in increasing the sustainability of environment.
11. Food loss and waste: Wastage of food results in loss of resources (water, land, energy, labour and capital) and finally results in greenhouse gas emissions which leads to climate change.
12. Nuclear techniques: Through its joint FAO/IAEA and its Agriculture and Biotechnology laboratories, uses nuclear techniques to support climate smart agriculture for:
    a. Increasing agricultural productivity sustainably.
    b. Adapt and build the resilience of agricultural and food security systems to climate change.
    c. Reduce green house gas emission in agriculture.

Objectives of Climate Smart Agriculture

1. Sustainably increase agricultural productivity and incomes.
2. Adapt and build resilience to climate change.
3. Reduce/Remove green house gas emissions where possible.

Main Features of Climate Smart Agriculture

1. Addresses adaptation and build resilience to shocks
2. Consider climate change mitigations as a potential co-benefit.
3. Location specific and knowledge intensive approach.
4. Identifies integrated options that create synergies and reduce trade-offs.
5. Identifies barriers to adoption and provides appropriate solution.
6. Strengthens livelihoods by improving access to services, knowledge and resources.
7. Integrates climate financing with traditional sources of agricultural investment.

Steps Taken for Climate Smart Agriculture in India

1. Under the Saansad Model Village initiate of government, each member of parliament may develop at least one climate smart village.
2. NICRA (National Initiative on Climate Resilient Agriculture) Project which encompasses:
    a. Strategic research to address long term climate change.
    b. Demonstration of innovative and risk management technology in different parts of country.
    c. Funding competitive research.
    d. Capacity building of different stakeholders for greater awareness and community action.
3. Agro forestry policy
4. Use of solar power
5. Precision agriculture
6. Mapping hotspots of germplasm collection
7. Flood mapping and insurance
8. Empowering women leaders
9. Loss assessment for crop insurance
10. Weather based crop insurance
11. Soil health card scheme
12. Food security bill which promote climate resilient coarse grain cultivation
13. Ban on burning straw

ISSN : 2279-0454
July - September, 2019

12

HEALTH MANAGEMENT IN DIVERSIFIED AQUACULTURE SYSTEM

Ratan Kumar Saha
Central Agricultural University, Imphal, Manipur
**Email: ratankumarsaha123@gmail.com*

Health management is a term used in aquaculture to describe good management practices (GMPs) or best management practices (BMPs), which are designed to prevent aquatic animal diseases and to maintain the overall hygienic condition of the culture systems. Once aquatic animals get sick it is very difficult to salvage them. Successful aquatic animal health management begins with the prevention of disease rather than treatment. Prevention of aquatic animal disease is accomplished through good water quality management, nutrition, and sanitation. Therefore, we can say health management is:

- To prevent disease development to healthy animals.
- To prevent propagation of existing disease-causing agents (pathogens).
- To strengthen the immune system.
- To monitor hygienic environment.
- To produce healthy & high-quality fish/prawn etc.

Health Management and Biosecurity

- Biosecurity can be defined as 'the measures and methods adopted to secure a disease-free environment in all phases of aquaculture practices (i.e., hatcheries, nurseries, grow-out farms) for improved profitability'.
- In short, food producers have consumer safety as their primary target. If the food they produce is not safe, no economic model works.
- The second and equally important target is economic prosperity.
- Part of this process is biosecurity. It touches all the bases: environmental integrity, animal welfare, food safety and economic gain.
- Biosecurity measures are the management practices that prevent non-infected, healthy animal populations from being exposed to infectious or parasitic agents.
- Finally, 'Biosecurity' in aquaculture is defined as an essential group of tools for the prevention, control, and eradication of infectious disease and the preservation of human, animal, and environmental health.
- Biosecurity can also be applied to diversified aquaculture production systems through a variety of management strategies:
  - Reliable sources of stock,
  - Adequate diagnostic and detection methods for excludable diseases,
  - Disinfection and pathogen eradication methods,
  - Best/Good management practices (BMPs or GMPs), and
  - Practical and acceptable legislation.
- Further, Biosecurity programme may be of following types:
  - Terminal disinfection Programme
  - Continuous disinfection Programme
  - Specialist disinfection Programme

Nevertheless, it is almost impossible to determine the economic benefits of a biosecurity program if there is no disease outbreak, and aquaculture producers may be reluctant to adopt biosecurity measures that appear to be an additional cost. Finally we can conclude that properly implemented biosecurity measures will limit the spread of disease causing organisms.

ISSN : 2279-0454
July - September, 2019

Biosecurity in Aquatic Animals

- These control strategies include both physical and biological aspects.
- The physical aspects start with cleaning and disinfecting measures in hatchery and production facilities.
- The next step is disinfecting incoming water and waste water.
- In terms of the biological aspects of disease control, brood stocks undergo health inspections to ensure they are pathogen-free, and the health of the fry is routinely monitored.

Biosecurity and Principles of Ecosystem

Following 12 principles are complementary and interlinked and we have to follow during the management of a diversified system:

Principle 1: The objectives of management of land, water and living resources are a matter of societal choices.

Principle 2: Management should be decentralized to the lowest appropriate level.

Principle 3: Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.

Principle 4: Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management program should:

- Reduce those market distortions that adversely affect biological diversity;
- Align incentives to promote biodiversity conservation and sustainable use;
- Internalize costs and benefits in the given ecosystem to the extent feasible.

Principle 5: Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.

Principle 6: Ecosystem must be managed within the limits of their functioning.

Principle 7: The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.

Principle 8: Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.

Principle 9: Management must recognize the change is inevitable.

Principle 10: The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.

Principle 11: The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.

Principle 12: The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

Levels of Aquatic Animal Disease Diagnostics

- **Level I** (farm/production site observations, record-keeping and health management) is strongly emphasized as this forms the basis for triggering the other diagnostic levels (II and III).
- **Level II** includes the specializations of parasitology, histopathology, bacteriology and mycology, which requires moderate capital and training investment, and which, generally-speaking, cannot be conducted at the farm or culture site.
- **Level III** comprises the types of advanced diagnostic specialization which requires significant capital and training investment. The immunology and biomolecular techniques are included in Level III, although field kits are now being developed for farm or pond-side use (Level I) as well as use in microbiology or histology laboratories (Level II). These efforts are good indication that technology transfer is now enhancing diagnostics and, with solid quality control and field validation, it is certain that more Level III technology will become field accessible in the near future.

Typical Questions on Aquatic Animal Kill

Following are the typical questions to be asked on an aquatic animal kill:

1. Where and when was the fish kill discovered?
2. Size and depth of the pond/ water body?

ISSN : 2279-0454
July - September, 2019

3. Source of water?
4. What is the water temperature?
5. What type and how many aquatic plants?
6. Any recent agricultural spraying or animal waste runoff?
7. Any recent thunderstorm or hot, cloudy weather?
8. What species of fish were killed?
9. Was just one species of fish killed?

Simple Explanation of Aquatic Animal Kill

1. The 100 % disaster was likely due to the shortage of oxygen.
2. A fish kill can occur in any type of water body.
3. The degradation of domestic waste absorbs oxygen and promotes nitrite that uses oxygen to go to nitrate.

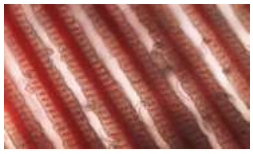
Fig. 1 Algal bloom/ Eutrophication

Fig. 2 Removal of Algal bloom with Water Hyacinth

4. Algae and protozoan dinoflagellates bloom enormously.
5. In sunlight, microorganisms produce oxygen.
6. At night, this plankton community uses it.
7. You can see what will happen to the fishes and invertebrates in the early morning hours.
8. A fish kill of this magnitude demonstrates the fragility of the environment.

Some Common Aquatic Animal Diseases of NEH Region

Ergasilosis (*Ergasilus* sp.)



Monogenic trematodes (Dactylogyrosis)

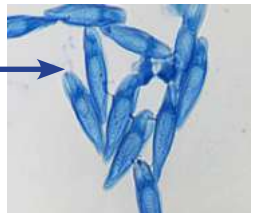
Motile aeromonad infection (MAI)

Fish infected with *Argulus* sp.

Argulosis or Fish lice

Tail & Fin Rot (*Aeromonas* spp. & *Pseudomonas* spp.)

EUS (*Aphanamyces invadans*)



White gill spot disease (*Thelohanellus catlae* & *Myxobolus* spp.)

Reddish Blotch/ Ulcer disease (Bacterial disease)

Dropsy (*Aeromonas* sp.)

Gill Rot disease (Fungal disease)

Nutritional disease in fish

Prawn showing Isopod infestation

Low Regulatory Priority Aquaculture Drugs

Following low regulatory priority aquaculture drugs and chemicals to be used in a diversified aquaculture system for prevention of diseases:

ISSN : 2279-0454
July - September, 2019

Name of the products/ chemicals	Dosage and application
Acetic Acid	1000 to 2000 ppm dip for 1 to 10 minutes as a parasiticide for fish.
Calcium Oxide	Used as an external protozoacide for fingerlings to adult fish at a concentration of 2000 mg l^{-1} for 5 seconds.
Calcium Carbonate	Used to increase water calcium concentration to ensure proper egg hardening. Dosages used would be those necessary to raise calcium concentration to 10 – 20 mg l^{-1} $CaCO_3$. Also, used up to 150 mg l^{-1} indefinitely to increase the hardness of water for holding and transporting fish in order to enable fish to maintain osmotic balance.
Carbon Dioxide Gas	For anesthetic purposes in cold, cool, and warm water fish.
Fuller's Earth	Used to reduce the adhesiveness of fish eggs to improve hatchability.
Garlic (Whole form)	Used for control of helminth and sea lice infestations of marine salmonids at all life stages.
Hydrogen Peroxide	Used at 250 – 500 mg l^{-1} to control fungi on all species and life stages of fish, including eggs.
Ice	Used to reduce metabolic rate of fish during transport.
Magnesium Sulfate	Used to treat external monogenic trematode infestations and external crustacean infestations in fish at all life stages. Used in all freshwater species. Fish are immersed in a 30,000 mg $MgSO_4$ l^{-1} and 7000 mg NaCl l^{-1} solutions for 5 to 10 minutes.
Onion (Whole form)	Used to treat external crustacean parasites, and to put off lice from infesting external surface of fishes at all life stages.
Papain	Use of a 0.2% solution in removing the gelatinous matrix of fish eggs in order to improve hatchability and decrease the incidence of disease.
Potassium Chloride	Used as an aid in osmoregulation; relieves stress and prevents shock. Dosages used would be those necessary to increase chloride ion concentration to 10 – 2000 mg l^{-1}.
Povidone Iodine	100 ppm solution for 10 minutes as an egg surface disinfectant during and after water hardening.
Sodium Bicarbonate	142 – 642 mg l^{-1} for 5 minutes as a means of introducing carbon dioxide into the water to anesthetize fish.
Sodium Chloride	0.5% to 1.0% solution for an indefinite period as an osmoregulatory aid for the relief of stress and prevention of shock; and 3% solution for 10 to 30 minutes as a parasiticide.
Sodium Sulfite	15% solution for 5 to 8 minutes to treat eggs in order to improve their hatchability.

Conclusion

Management of aquatic animal health is a complex problem that encompasses a philosophical as well as a scientific and technical approach. In well managed culture conditions aquatic animals are found to be more or less resistant to pathogens. Poor water quality, infected feed and rough handling can make the animals weaker and make them susceptible to diseases caused by bacteria, fungus, virus, parasites or even worms. Therefore, prevention of fish disease is accomplished through good water quality management, nutrition and sanitation or GMPs (Good Management Practices). Farmer must develop a holistic approach by combining environmental management and therapeutic treatment. Prevention is always better than cure.

ISSN : 2279-0454
July - September, 2019

AUTHORS' GUIDELINES

Tips to Write the Article

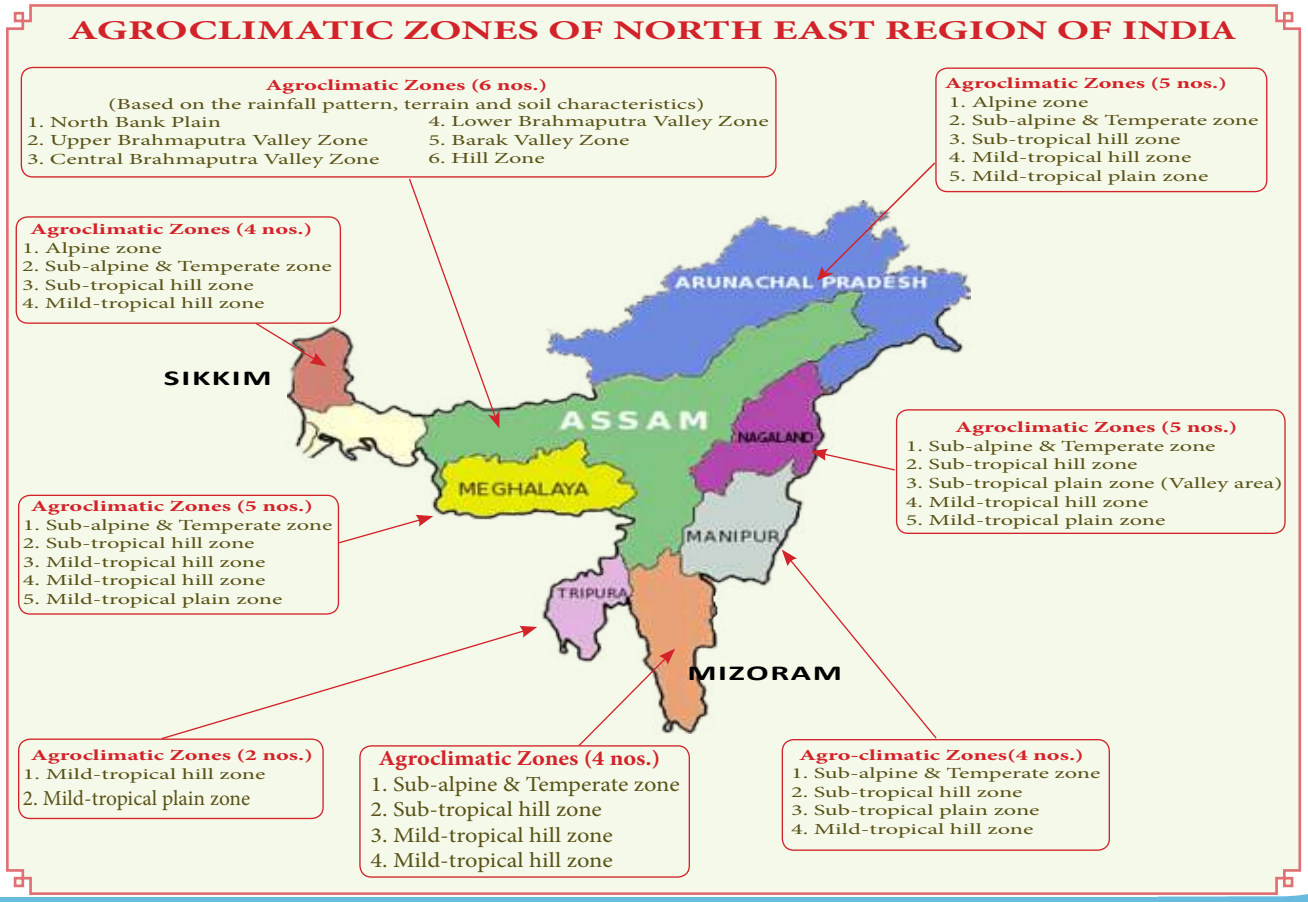
- Article(s) in '**CAU Farm Magazine**' range in length from 2 to 5 pages of A4 size with black and white and/or colour illustrations/ photos in JPEG format with the caption.
- The Manuscript should be prepared in MS word in Times New Romans with 1.25 line spacing (Title should be in 11font uppercase in bold letters, authors name capital each word in 11font (bold), address in italic, text in 10 font and scientific/ local/ common name should be in italic).
- The title should be attractive to catch the attention of the readers.
- Type the name, address, phone number and email of the corresponding author below the title on the first page in the left-hand comer.
- Include a one or two-sentence biographical statement about the author(s) which will be used at the end of the article.
- Abbreviations or symbols used should be defined once (first time).
- Use natural, but interesting language. Write using concrete nouns and active verbs. Emphasize short sentences, but vary the length to create and hold interest.
- Avoid writing in the passive voice. Simple words are often better. Pay attention to transitions between paragraphs.
- The Farm Magazine articles may have scientific terms, but they should not sound academic. Focus on facts not fluff.
- Reference(s) should not be included.
- Avoid including more than three names as authors of the article.
- Nature of work of authors should have relevance to the submitted articles.
- The trade names of chemicals viz., insecticide/ pesticides/ weedicides, probiotics, prebiotics, hormones, biofertilizers etc. should also be included along with their respective generic names.
- Figure caption should be given below while table title should be given above.

Policy

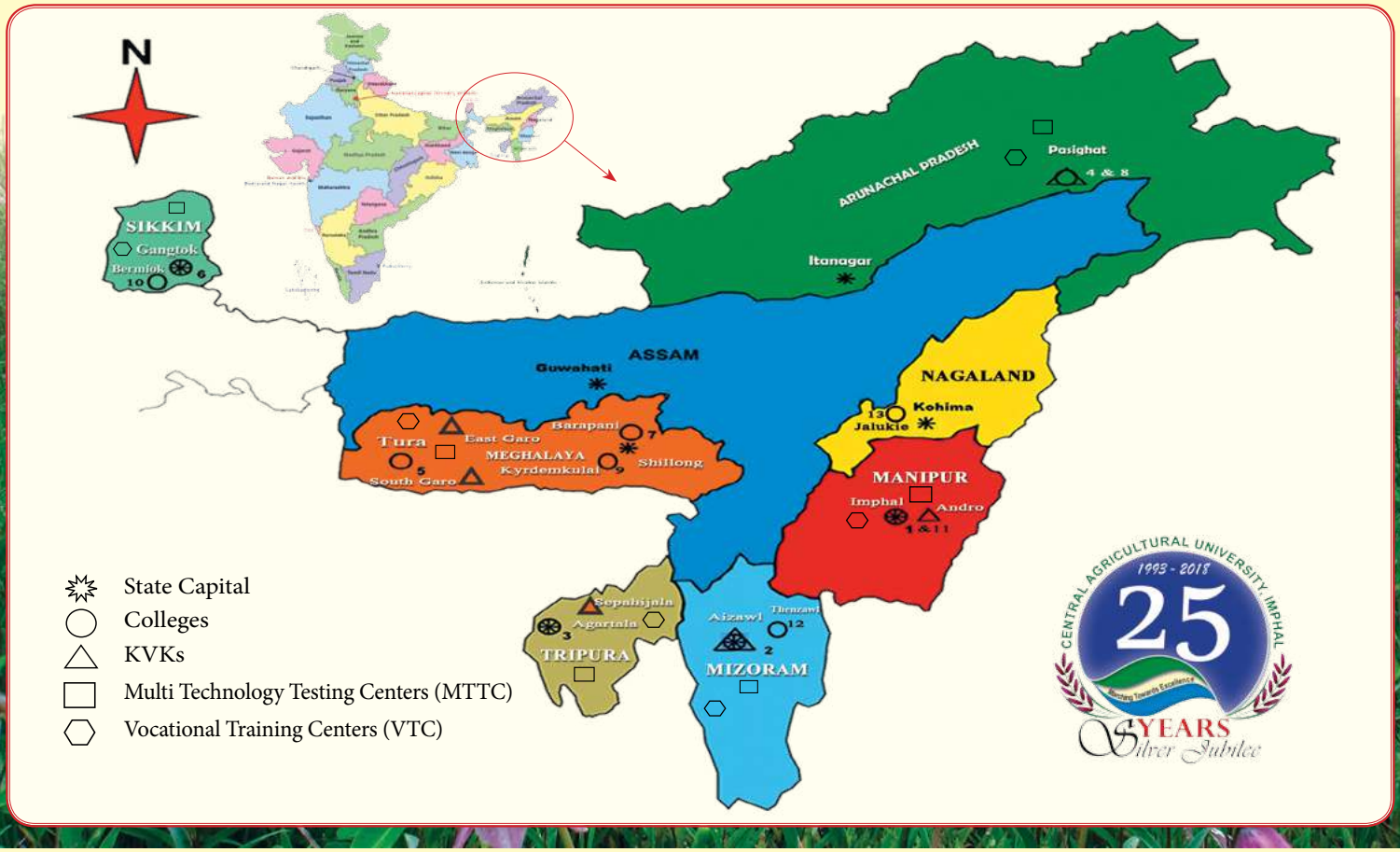
Provide complimentary copies including soft copy for the writers. '**CAU Farm Magazine**' accepts no responsibility for the return of manuscripts that are not accompanied with the corresponding address, email address, and mobile number. The acceptance letter will be communicated to the given email. The editorial committee is not responsible for the views expressed by the author(s).

Contact Information

Send material for publication, or queries to:
Chief Editor, CAU Farm Magazine, Directorate of Extension Education, Central Agricultural University
P.O. Lamphelpat, Imphal, Manipur, PIN: 795 004, India
Email: cau.publicity@gmail.com



CENTRAL AGRICULTURAL UNIVERSITY, IMPHAL, MANIPUR



Constitutent Colleges,KVKs, VTCs & MTTCs of Central Agricultural University, Imphal

1. College of Agriculture, Imphal, Manipur
2. College of Vety. Sc. & AH., Selesih, Aizawl, Mizoram
3. College of Fisheries, Lembucherra, Agartala, Tripura
4. College of Horticulture & Forestry, Pasighat, Arunachal Pradesh
5. College of Community Science, Tura, Meghalaya
6. College of Agri. Engg. & PHT, Gangtok, Sikkim
7. College of P G Studies in Agricultural Sc., Umiam, Meghalaya
8. College of Agriculture, Pasighat, Arunachal Pradesh
9. College of Agriculture, Kyrdemkulai, Meghalaya
10. College of Horticulture, Bermiok, Sikkim
11. College of Food Technology, Imphal, Manipur
12. College of Horticulture, Thenzawl, Mizoram
13. College of Vety. Sc. & AH., Jalukie, Nagaland
14. Krishi Vigyan Kendra, Impahl East, Andro, Manipur
15. Krishi Vigyan Kendra, Aizawl, Mizoram
16. Krishi Vigyan Kendra, East Siang, Arunachal Pradesh
17. Krishi Vigyan Kendra, East Garo Hills, Meghalaya
18. Krishi Vigyan Kendra, South Garo Hills, Meghalaya
19. Krishi Vigyan Kendra, Sepahijala, Tripura

O Colleges (Total 13) * State Capital

△ KVKs (Total 6)

⬡ Vocational Training Centers (Total 6)

▭ Multi Technology Testing Centers (Total 6)

2279-8454

Book-Post

From
The Chief Editor
CAU Farm Magazine
Central Agricultural University
lamphelpat, Imphal - 795 004
(INDIA)

To

.....

.....

.....

.....