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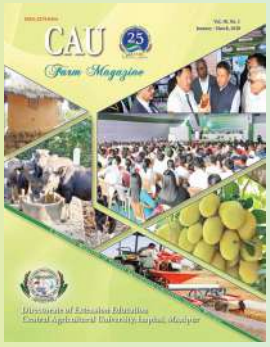
For any queries and advertisement contact:
Chief Editor
CAU Farm Magazine
Mobile: 9436122795
Email: cau.publicity@gmail.com



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Layout & Design

Y. Premchand Singh
Computer Operator, DEE, CAU, Imphal

Technical Assistant

G. Amritkumar Sharma,
Y. Sanjoy Meitei, W. Khagemba Singh,
Mrs. Narita L., O. James Singh

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From the Editor's Desk

This 10th edition comes out at a very crucial moment, the incidence of which has not been witnessed in more than a century. The world has been virtually put to a halt by the Coronavirus pandemic. While the world has come to terms with letting economic health take a back seat during this battle, the real challenge is ensuring food security. So, if doctors, health workers, security forces, and district administration are our frontline soldiers, the agricultural community has to be the backbone of the country right now.

The stress of locked-down markets has been far greater on farmers than that on the consumers because our existing supply chain was not prepared for this eventuality. Nevertheless, we are adapting to this new norm, and the best we can do right now is to ensure a steady supply of food grains and other essential products so that we don't add another variable to the problem.

I urge you to be at the forefront, in each of your capacities, in this fight to protect the agricultural sector during these difficult times. Apart from carrying out your usual duties, you will have to and help others adapt to new solutions. New platforms for the sale of produces have and will come up, and stakeholders will need our handholding now more than ever before. All this while, we will have to be careful and educate those around us on precautions against the spread of this virus and safety measure to be taken at work.

I hope this issue will help you ease a little in this anxious hour. Please utilize the knowledge you achieve after going through every article. If you can incorporate the knowledge shared by our learned scientists, then the purpose of this magazine is served.

Further, I would like to pay my sincere thanks to Hon'ble Vice-Chancellor and Patron of the Editorial Board, Prof. M. Premjit Singh for his constant support and encouragement for publishing the CAU Farm Magazine in time and also extend the thanks to all the members of Advisory Board; Editor, Dr. Dipak Nath, Dy. Director (EE), and Asst. Editor, Dr. Indira Thounaojam, IPO. Thanks, are also due to Mr. Y. Premchand Singh, Computer Operator, and Mr. G. Amritkumar Sharma, Video- photographer for their innovative ideas to bringing this 1stIssue of the 10thVolume of this magazine with a new look.

At the outset, as Chief Editor, I hope that all the scientists, contributors, readers, farmers, and well-wishers will help us in publishing CAU Farm Magazine in a far better way with new-new innovations, ideas, and thoughts for the farming communities during and after COVID 19.

(Prof. Ratan Kumar Saha)
Chief Editor

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SPENT MUSHROOM SUBSTRATE - A MULTIFACETED UTILITY FOR ORGANIC AGRICULTURE

Shweta Singh, Ravikant Avasthe, Chandramani Raj, Chandan Kapoor and Sangay C. Lepcha
ICAR-National Organic Farming Research Institute
Tadong, Gangtok, Sikkim-737102
Email: shwetabac@gmail.com

Mushrooms are commonly known for their delicacy and nutritional value but the substrate released after mushroom crop harvest, better known as 'Spent Mushroom Substrate' is also a subject of great importance. The 'spent mushroom substrate' (SMS) can be defined as the compost released after the harvest of one full crop of mushroom, beyond which extension of crop becomes unremunerative (Ahlawat and Sagar, 2007). The term spent mushroom substrate or spent compost has been replaced by a term, "post mushroom substrate" (PMS) because it is not 'spent' but is ready to be further worked upon by a new set of microorganisms. About 1 kg production of fresh mushroom generates 5 kg of SMS. Researchers have proved that spent mushroom substrate has the quality of good organic manure which further gets enriched during its recomposting by natural weathering or any other process and is suitable for raising healthy crops of cereals, fruits, vegetables and ornamental plants. It also has the potential to reclaim the contaminated soils (Ahlawat *et al.*, 2007a). As the mushroom industry is steadily growing, the volume of SMS generated annually is increasing. In recent years, the mushroom industry has faced challenges in storing and disposing the SMS. Piling up of "spent mushroom substrate" released after mushroom crop harvesting is a serious environmental concern due to ground water contamination and other hazards, if not utilized properly (Beyer, 1996). Mushroom industry needs to dispose off more than 50 million tons SMS each year across the world (Fox and Crover, 1999). The large dumped piles of spent mushroom substrate become anaerobic and give off offensive odor. The run-off from such piles contaminates nearby water sources and pollutes them. During the recent years, environmental legislations have forced the mushroom growers to come out with more amicable ways of SMS disposal. Apparently, the

Fig. 1 Dumped spent mushroom substrate of oyster mushroom

obvious solution is to increase the demand for SMS through exploration of new applications for its utilization. It would be more economical and favourable if SMS is to be recycled and reused.

At the same time, the demand for organic residues and compost has also increased several folds considering importance of organic farming. Besides, one of the basic principles underlying organic farming is to utilize the low cost locally generated on-farm inputs for enhancing the organic produce and also to ensure diversified sources of nutrition to the soil. Although farm yard manure is mostly being used for production of organic food, its poor availability has restricted the production of organic crops at a large scale. Fortunately, SMS has many of the requisite attributes still left with for its exploitation in place of FYM in raising organic field crops and environment management.

SMS is commonly made from renewable agricultural residues such as paddy/wheat straw, sawdust, sugarcane bagasse, oil palm empty fruit bunch, hay, poultry manure, ground corncobs, cottonseed meal, cocoa shells, gypsum and other substances

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(Jordan *et al.*, 2008). The recomposted spent mushroom substrate has multifacet utilities in improving the yield and quality of the crop, and also management of the diseases, which is really encouraging for the mushroom industry as well as organic farming. The other utilities of spent mushroom substrate are in vermicomposting, bioremediation of contaminated soils, heavy metals, pesticides and preparation of organic-mineral fertilizer which is a boon to the organic farming system of the country. The addition of spent mushroom substrate in nutrient poor soil improves its health by improving the texture, water holding capacity and nutrient status. However, it reduces the soil's thermal conductance, bulk density and water stable aggregates (>0.25 mm). Spent mushroom substrate incorporation in soil leads to an increase in both pH as well as the organic carbon content (Sagar *et al.*, 2009).

Properties of Spent Mushroom Substrate

The spent substrate from different mushrooms varies in its physical, chemical and biological properties and each one has its own specific utility. The SMS has been found to be a good nutrient source for agriculture mainly because of its rich nutrient status, high cation exchange capacity (CEC) and slow mineralization rate which helps it retain the quality as an organic matter. SMS contains 45% water and is light in weight SMS contains much less heavy metals than sewerage sludge, which precludes its classification as hazardous substance. Spent mushroom substrate contains high amount of salts and other elements which are harmful to plant growth and need to be leached out to make it usable for agricultural/ horticultural activities (Ahlawat and Sharma, 2007). In order to make SMS suitable for its use as manure, it is exposed to natural climatic conditions like varied temperature and rainfall, which is called as weathering of SMS. Weathering makes required improvement in the characteristics of SMS but at the same time it also releases leachate containing nitrates and other nutrients. Weathering causes a slow decrease in the organic matter contents (volatile solids) and leads to different characteristics of weathered SMS because of on-going microbial activity. The SMS obtained from different sources usually has conductance in the range of 1.9 to 8.3 mmhos cm^{-1} (Gerrits, 1987). The volume of SMS also decreases (shrinkage) over time. The composting of SMS in semi-enclosed drums for 6 weeks enhances its bulk density from 0.256 g cm^{-3} to 0.293 g cm^{-3} (Lohr *et al.*, 1984).

Applications of Spent Mushroom Substrate

The exploitation of spent mushroom substrate can be put to diversified uses for organic agriculture and environmental issues owing to their physical, chemical and microbiological properties. Some of the important applications of SMS in organic farming have been depicted in **Fig. 2** and discussed below:

a) Spent mushroom substrate as organic fertilizer

Spent mushroom substrate (SMS) normally contains

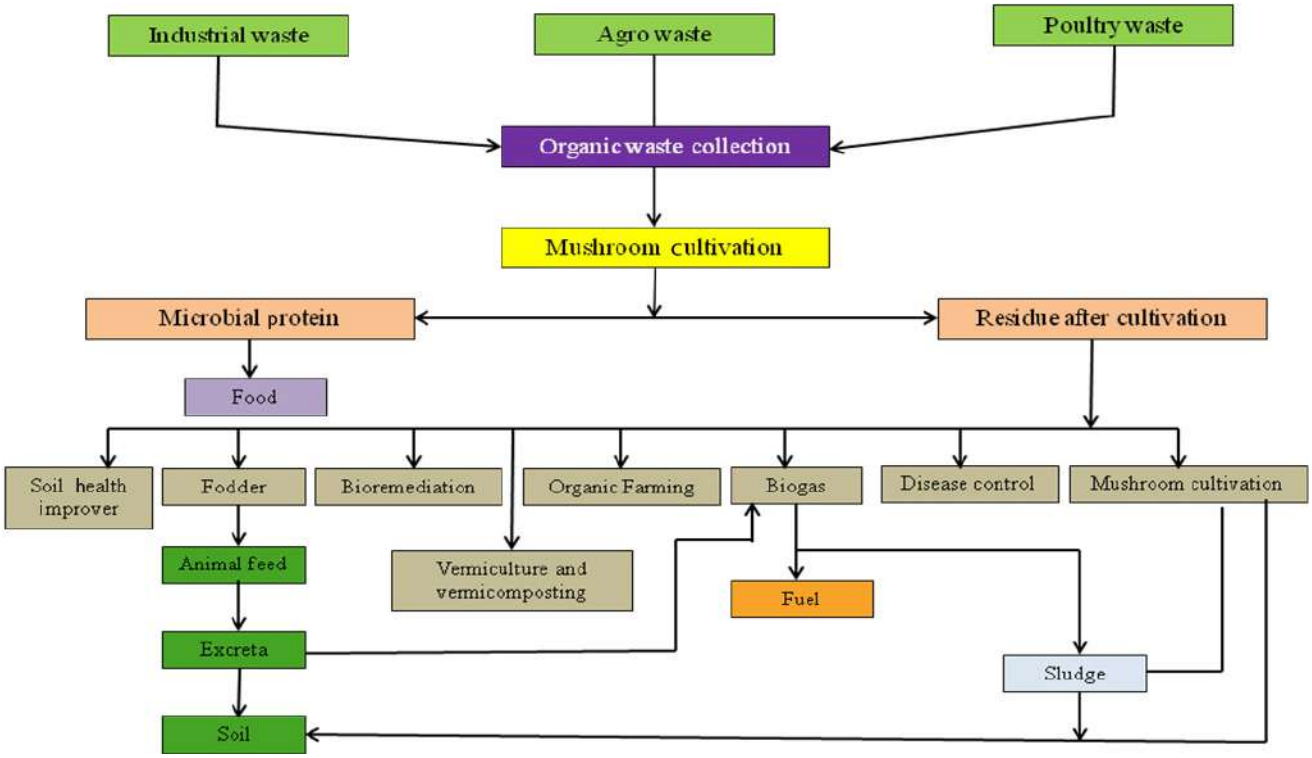

Fig. 2 Recycling of spent mushroom substrate

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1.9:0.4:2.4%, N-P-K before weathering and 1.9:0.6:1.0, N-P-K after weathering for 8-16 months (Gupta *et al*., 2004). Nitrogen and phosphorus do not leach out during weathering but potassium being more leachable is lost in significant amount during weathering. Spent mushroom substrate is still nutrient-rich and contains about 80% of the total nitrogen in bound form with high molecular weight fractions of lignin and humic substances. On the other hand, phosphorus, potassium, micro-nutrients and the growth substances in SMS are present in sufficient quantity and in the available form. The phosphorus and potassium requirements of the crop plants can be fully met by incorporating 5% of SMS by volume, while nitrogen requirement by 25% of SMS by volume. Availability of nutrients from SMS can be enhanced by preparing an organic-mineral fertilizer from the spent mushroom substrate. The absorption capacity of stable 'humus' available in SMS helps in retention of nitrogen in the top soil. Conversion of SMS into an organic-mineral fertilizer is an alternative way of using spent mushroom compost for soil amelioration and to make it a balanced source of nutrition for plant growth.

b) Spent mushroom substrate for disease management

The actinomycetes, bacteria and fungi inhabiting the compost not only play a role in its further decomposition but also exert antagonism to the plant pathogens surviving and multiplying in the soil ecosystem. The amendment of soil with spent mushroom substrate restricts the root knot infestation of tomato plants caused by Meloidogyne incognita. Under *in-vitro* conditions, the anaerobically fermented aqueous extract of the SMS inhibits the conidial germination of *Venturia inaequalis*, the causal agent of apple scab. The extract also inhibits the conidial germination of *Cochliobolus carborum* and *Sphaeropsis sapinea* (*Diplodia pinea*) causing diseases on maize and red pine (*Pinus resinosa*), respectively. The extent of black rot disease in cole crops have been reported to reduce by 60% in soils manured with anaerobically recomposted SMS and reduction of powdery milt and *Fusarium wilt* in pea by three to four folds (Yohalem *et al*., 1994). The aqueous extract obtained after 5 to 9 days of incubation in the ratio of 2:1 to 4:1 (Water: SMS) maintains its efficacy for about 4 months on storage at -20ºC, 4ºC and room temperature. The biological analysis of obtained SMS extract shows that it contains a *Pseudomonas* and a *Bacillus* strain. SMS obtained from different growers harbours different mycoflora and shows differences in its effect on inhibition of conidial germination and disease suppression. The inhibitory properties of SMS remain unaffected even after autoclaving and filter sterilization of aqueous extract. Weekly or bi-weekly application of spreader/sticker amended SMS extract, starting from green tip to petal fall of apple tree reduces the scab-affected leaf area. It maintains higher population of bacteria even after one month of the final spray which is the reason for less scab affected leaf area in SMS sprayed treatment (Yohalem *et al*., 1996).

c) Vermicomposting

The spent substrate from paddy straw, oyster and button mushrooms is also suitable for vermicomposting. Fresh as well as 15-20 days old rotten spent mushroom substrate from white button, oyster, milky and paddy straw mushrooms is an acceptable material for the worms to multiply and to convert it into manure for field crops. The SMS can be used as a vermicomposting medium either alone or in different combinations either with FYM, agricultural or vegetable farming wastes depending upon their availability. Decomposition of SMS takes minimum of six months and quality manure from SMS can only be prepared by long term decomposition. The duration of SMS decomposition can be shortened to few weeks by vermicomposting of SMS. The time for vermicomposting with SMS varies between 2 to 2.5 months.

Fig. 3 Vermicompost prepared from spent oyster mushroom substrate in low cost unit at ICAR-NOFRI, Tadong

d) Mushrooms

Mushroom spent substrate is not considered totally exhausted from the production of mushrooms. Thus, considerable research and practice have attempted to recycle the "spent" material in further mushroom production. Production of second crop of mushroom from the spent substrate can prove to be more efficient utilization of the substrate ingredients and can also ameliorate the problem of solid waste disposal in the mushroom industry (Fahy and Wuest, 1984). Re-spawning of *Agaricus* spent compost together with the addition of spawn mate (helps in delayed – release of nutrient) and peat as adsorbent material can give good yield of second *Agaricus* crop. The shiitake spent mushroom substrate supplemented with 10% wheat

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bran and 10% millet can be utilized for *Pleurotus sajor-caju* cultivation, after air -drying, grinding, supplementation, pasteurization and spawning of spent substrate (Royse, 1993). Another use of SMS in mushroom cultivation is as casing material for button mushroom. The use of aerobically fermented spent mushroom substrate as casing material gives mushroom yield at par with peat based casing material with an additional advantage of less bacterial blotch (*Pseudomonas tolaasii*) infection on fruiting bodies than those from peat-based casing material (Szmidt, 1994; Ahlawat and Vijay, 2004). The SMS based casing also lowers dry bubble disease incidence in comparison to coir pith.

e) Bioremediation of contaminated soil

The uncontrolled release of industrial wastes in the open and poor availability of pre-treatment facilities contribute towards increased level of contaminants in the soil. The degradation of these contaminants mainly depends upon the physical and chemical conditions of the soil and the nature of microorganisms thrive in the soil. SMS adsorbs the organic and inorganic pollutants and harbours diverse category of microbes, which have the capability of biological break down of the organic xenobiotic compounds. The microbes, especially actinomycetes (*Streptomyces* sp. and *Thermomonospora* sp.) present in spent mushroom substrate also have strong pollutants catabolizing capabilities which result in decreased level of pollutants in contaminated soil after incubation with SMS (Ahlawat *et al*., 2007b). The spent mushroom substrate also has decontamination potential for land sites used for disposal of hazardous wastes.

f) Bioremediation of heavy metals

In addition to being a rich nutrient source for various field crops, spent mushroom substrate originated from different edible mushrooms possesses unique physicochemical and biological properties, which make SMS an ideal bioremediative agent for various environmental protection activities. The mixing of spent mushroom substrate @ 10, 20 and 30%, w/w result in faster degradation of lead and cadmium in soil in comparison to soil without any amendment of SMS. It has been recorded that metals decrease at sharpest rate in 30% SMS, w w^{-1}, mixed soil. The level of cadmium & lead reduces to undetectable limit after six months of SMS mixing in soil under in-situ conditions (Gupta *et al*., 2006). The sharp decrease in level of heavy metals in SMS mixed soil occurs because of the isolated biomass of SMS which works as an ion exchanger. The microflora thriving on SMS have been found to be responsible for faster heavy metals bioremedation in SMS mixed soils.

Farmers' Indigenous Knowledge on Uses of SMS

Mushroom growers are recycling spent mushroom substrate naturally and using it in agricultural and horticultural crops as manure on their own. They have gained a lot of experience in it and are sharing their knowledge within the locality. SMS is being used by the growers as manure in several crops, *viz*., capsicum, tomato, cauliflower, pea, potato, ginger, garlic, wheat, paddy, maize and apple. Mushroom growers have observed that spent compost considerably increases the level of soil fertility, water holding capacity, porosity and texture on applying as manure. Both mushroom growers and researchers have noticed that the application of SMS in soil enhances the crop yield and manages diseases in agricultural and horticultural crops, in addition to improvement in soil physical conditions. On the basis of experiences gained during the process of verification of ITKs about use of SMS as manure in crops, it can be concluded that SMS should be decomposed for atleast 12 months, either by natural weathering in pits or aerobic/anaerobic recomposting, instead of disposing off in open on road side. Similarly, the doses of recomposted SMS for various crops should be worked out on the basis of total nutrient (NPK) requirement of the respective crop and the nutrient status of the soil SMS^{-1}. The recomposted SMS can be used singly as basal application or in combination with inorganic fertilizers (Ahlawat and Sagar, 2007).

Conclusion

SMS is no longer regarded as a waste but as a renewable resource from the mushroom industry. Not only can SMS be employed in a number of green technology endeavours, the enzymes recovered are potentially useful for the bioremediation of pollutants and other industrial biotechnology purposes. Having said that, the consistency in performance of the SMS has to be evaluated and assured in order to realise the application of SMS and SMS-related products in the near future.

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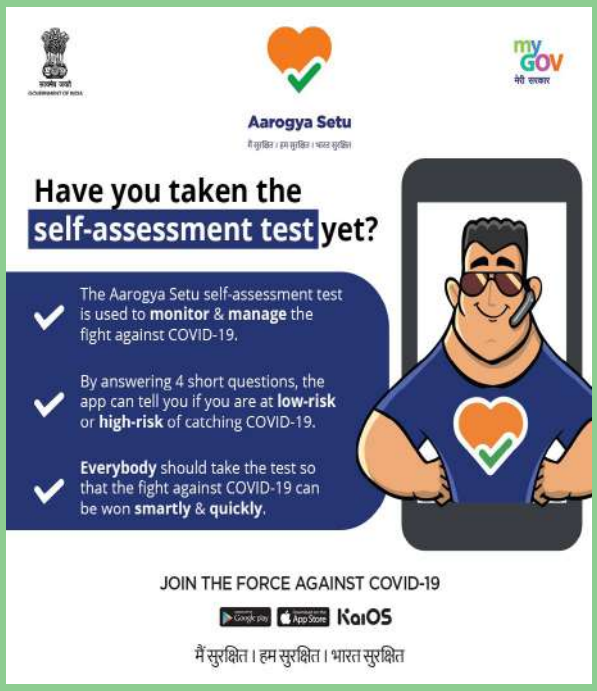

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NEED OF COMMERCIALIZATION OF ARTIFICIAL INSEMINATION IN PIGS

Tukheswar Chutia, Bhabesh Mili, M. O. Kurien and G. Dhanan Jaya Rao
College of Veterinary Sciences and Animal Husbandry (CAU, Imphal)
Jalukie-797110, Peren, Nagaland
Email: tukheswar@gmail.com

Livestock is an integral part of agriculture farming in India. It contributes 4.1% of total national GDP, which is highest amongst agriculture and allied sectors. Among all livestock species, pig has a huge potential to contribute faster economic return to the farmers, because of high fecundity, better feed conversion efficiency, early maturity and short gestation interval. The marginal farmers, especially in entire North Eastern region of India have enormous opportunity to improve their socio economic status and livelihood through piggery. Almost every household of North Eastern region consumes pork. Latest livestock census data shows a declining trend of pig population from 13.52 million (17th Livestock census) to 9.06 million (20th Livestock census). Having potential to improve socio economic status and livelihood of tribal peoples, especially in North Eastern states of India, it necessitate improvisation of traditional piggery practices, especially breeding.

Piggery in India is mostly confined within the weaker section of rural society, especially within tribal masses. Although the government has offered attractive subsidy and scheme to the livestock entrepreneurs to boost up piggery industry, still this industry is not growing remarkably in our country. One of the major causes of declining trend of pig population is sticking with traditional method of breeding via natural service. In this system, a community boar is use for breeding within that community. No organized germplasm centre is available for pig in our country. Therefore, farmers are solely depended on natural service unlike developed countries. The rearing of boar for breeding is cost effective as well as is not feasible for backyard pig farmers, where they are confined to maximum 2 to 3 nos. of pig only. Thus, widespread use of AI will be an alternative to age old natural service with superior male germplasm for breeding will defiantly boost up piggery industry in our country.

A success of AI in terms of fertility lies on decision of right time for AI in a breedable female animal. Pig is a polyestrus and polytocous domestic animal, can yield many crops in a year. Gilt attains maturity at the age of 6-11 months depending on the size, breed and nutrition and other managemental factors. However, poor body condition, imbalanced nutrition may delay the onset of puberty and sexual maturity. The age of sexual maturity of exotic breed, crossbred and local pig varies from 9-11 months, 8-11 months and 6-7 months, respectively. The length of estrous cycles varies from 18-24 days in pig. The duration of estrus is 2-3 days; this may vary according to breed and age of the pig. Detection of estrus is paramount in order to achieve success in pig breeding. The estrus sign and symptoms are almost same in both gilts and sows; however the duration and intensity may vary. The signs of estrus includes swelling and reddening of vulva, pink and moist of vulva mucous membrane, mucus discharge, mounting on other animals, excited for male, off fed, pressing the swollen vulva against hard wall or floor, standing reflex with erect ears and arched back with rigid, motionless posture etc. It is always recommend that the female should always be bred or inseminated when it is in standing heat or estrus. However, it can't be detected in all cases, which can be easily recognized in the presence of a mature boar.

Breeding Management

The gilt should be bred only when it is physically fit and having the proper growth at the time of estrus. It is always recommended that gilt should not be bred in first heat/ estrus as it will most likely result in poor quality oocytes. Fence line contact or direct contact of the mature breeding boar for 15-20 minutes per day, stimulate the hypothalomo-pituitary-gonadal axis of gilts, and thereby hasten puberty. Gilt has a tendency to show signs of estrus when other penmates come

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to estrus. Therefore, housing estral and non-estral gilts or sow together may enhance reproductive activity of the delayed pubertal gilts. The delayed puberty can be overcome by hormonal therapy. Numbers of exogenous hormones have been used for augmentation as well as estrus synchronization in developed countries to enhance the reproductive performance in pig. Estrus synchronization coupled with fixed-time AI will be viable option to improve fertility rate in pig.

Fig. 1 Semen collection over a "Wooden Dummy" sow in the piggery unit of COVSc & AH, Jalukie, Peren, Nagaland

Fig. 2 Artificial Insemination in pig in the field, Jalukie, Peren, Nagaland

A healthy adult sow usually comes into estrus at around 5-7 days after post weaning. However, it also depends on farrowing to weaning interval. In commercial pig farm, weaning is done at various days of lactation, *viz*. 28 days, 35 days, 42 days or 56 days. Early weaning at 28 or 35 days of lactation does not have much effect on body weight loss in sow. Thereby, sow may be ready for next breeding/service within a week after weaning. The post weaning body weight has immense effect on reproductive performance in sow. A healthy sow exhibit next heat at the earliest, immediately after removal of lactation and suckling stimulus. However, weaning should not be done too early because it will depress the litter size. Sucking stimuli inhibit hypothalamo-pituitary-gonadal axis. Thus, removal of suckling stimulus causes activation of the same. A plan weaning of sow with different lactation length also render the estrus synchronization, this is called "natural synchronization of estrus". Understanding of endocrine profiles of pig especially on female reproduction, which has opened up a new vista in piggery through synthetic hormones therapy for enhanced reproductive efficiency, especially estrus synchronization coupled with fixed time AI.

Artificial Insemination of Pig

In Artificial Insemination, processed and preserved semen collected from genetically superior boar is deposited in the female reproductive tract at the time of estrus/heat by means other than sexual intercourse.

A double insemination is always ideal to meet maximum conception and fertility rate. Generally, AI is done on second day evening from the day of onset of estrus followed by third day morning at 12 hours interval in sow. In contrast, gilt should be inseminated on second day morning followed by late evening dose on the same day. Procedure of AI in pig is as follows:

1. Clean the vulva and perennial area of female pig with a tissue or blotting paper.
2. Stimulate the pig in a way that mimics the action of a boar by giving pressure on its back, stimulation of the flanks and gentle massage of the udder.
3. Take a sterilized catheter and lubricate the tip of the catheter with a sterile non-toxic gel.
4. Spread the vulva and gently insert the catheter upward and forward into the vagina anticlockwise as far as it will go so that it will get locked into the cervix.
5. Fit the semen container tightly into the open end of the catheter. Hold the semen container in upward direction with one hand and stimulate the pig simultaneously with the other hand.
6. Squeeze the empty semen container just after completion of flow of semen into the tract to prevent backflow of semen. Stimulate the pig for 1-2 minutes.
7. Remove the catheter slowly and gently clockwise.

Conclusion

Artificial Insemination technique has huge potential to improve livelihood of tribal farmers through piggery, especially in entire North Eastern states of India. This technique is only for cyclic animal, whose reproductive status is known. Exogenous hormonal therapy for manipulation of female reproduction will help a breeder to predetermine time for fixed time AI. Estrus synchronization coupled with a fixed time artificial insemination will minimize the cost of breeding, increase conception and fertility rate. Hence, commercialization of AI in pig will definitely boost up piggery industry in our country.

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POTENTIAL HORTICULTURAL EQUIPMENTS SUITABLE IN NORTH EASTERN REGION

Yumnam Jekendra Singh[1] and R. K.Tiwari[2]
[1]College of Food Technology (CAU, Imphal), Lamphelpat, Manipur
[2]AICRP on Farm Implements and Machinery, Bhopal, Madhya Pradesh
Email: rk96tiwari@gmail.com

India's share in world fruit and vegetable production is 10% and 13.40%, respectively. The horticulture sector in India is characterised by small, segregated farms with low per-hectare yields and huge post-harvest losses, owing to outdated practices. Fruits and vegetables are grown in less than 5% of the country's gross cropped area, compared to over 63% of the area used to grow foodgrains.

The North-eastern region comprises of eight states, *viz.*, Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Sikkim lying between 21.5°N - 29.5°N latitudes and 85.5°E - 97.3°E longitudes. It has a total geographical area of 262180 km^2 which is nearly 8% of the total geographical area of the country. In the whole of NE region, about 35% area is plain and the remaining 65% area is under hills. Whereas in Assam, plains account for 84.44% of its total geographical area and the remaining 15.56% area is under hills. Use of appropriate pre and post harvest practices for horticultural crops is vital for the success of the crops and to provide good return to the growers. Advances of suitable proven technologies need to be promoted through feasibility testing and frontline demonstrations for ensuring time and labour cost saving in plains of North Eastern Region. The detail of few potential equipments commercially available are mentioned below:

Nursery Seeder for Vegetable Crops

It consists of nozzle assembly, seed collection unit, seed tray moving device, pressure control unit and seed vibration unit. The provision for changing nozzle diameter, suction pressure, velocity of tray and frequency of vibration of the seed tray is provided. The machine is suitable for sowing three types of seeds of vegetables (cauliflower, brinjal and chilli). There is 52.-63.6% saving in cost of operation and 77.5-82.9% saving in labour as compared to manual seeding of nursery trays.

Manually Operated Gladiolus Planter

The gladiolus is an important crop under floriculture sown in larger area which requires huge labour (130 man-h ha^{-1}) for planting in traditional method. The peak season has paucity of labour and wages are also very high. For timely planting of gladiolus corm, a cost effective, light weight, small and manually operated gladiolus planter has been developed which reduces labour requirement and covers more area in season for gladiolus cultivation. The planting reduces human drudgery and accomplishes job timely in line ensuring judicious use of corms for planting in traditional method. It consists of a frame, seed box, seed tube, ground wheel, cup feed metering mechanism, shovel type furrow opener and handles. Cup feed type metering unit picks the gladiolus corm individually into the cups and delivers it into seed pipe. A cup feed metering mechanism with openable base is provided in the unit. The opening of the conical cup is controlled by spring loaded actuating metal finger. The movement of actuating finger is controlled by a vertical disc/plate which is driven from ground wheel through chain and two sprockets. Percent seed in upright, inclined and downward position vary from 36.67-38%, 53.27-58.67% and 3.33-10.06%, respectively. There is average 44.44% saving in labour and 39.44% saving in cost of operation as compared to traditional manual planting method.

Tractor Operated Mulch laying Machine

A tractor operated mulch cum drip laying cum seedling planter.consists of bund forming unit, fertilizer unit, mulch laying unit, drip laying arrangement, press wheel, punch planter unit and covering device. The bund former comprising of two MS plates attached to the main frame at the front bottom forms raised bunds. The size of bunds varies according to the requirement by changing the distance between the bund formers. The fertilizer unit is provided on the mulch laying machine to apply fertilizer at the time of mulch laying. Fertilizer box of size 620 × 460 mm made from MS sheet of 6

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mm thickness is employed. The star wheel type metering mechanism made of plastic is provided for metering of the fertilizer.

The punch planter arrangement is provided to make holes in the plastic mulch film and to plant seedling into the soil on the bund. The field trials of the machine can be conducted at moisture content of 12-14%. The effective field capacity is in the range of 0.08-0.12 ha h^{-1}. The observed draft may be 3610-3983 N. The fuel consumption is in the range 3.6-4.2 l h^{-1}

Tractor Operated Planter for Tissue Culture Banana

The labour requirement for pit digging and planting of tissue culture banana is 34 mandays ha^{-1} and constitutes 9% of the total labour requirement. The farmers necessiate for cost effective planting machine due to huge labour requirement in traditional method used for tissue culture banana planting. With the objective of planting quality tissue culture material precisely, the unit has been designed to plant judicious material timely and accurately at appropriate spacing, thus leading to higher productivity.

The tractor operated planter for tissue culture banana consists of the chisel type furrow opener, furrow enlarger, plants dispensing unit, earthling up assembly, operator seat and press wheel. Chisel type furrow opener opens the furrow to a depth of 300 mm. The furrow enlarger made up of sheet metal wings enlarges the furrow for the width of 120 mm and depth of 200 mm behind the chisel. The seedlings grown in the grow bag of 60 mm diameter and 150 mm height are placed in the spoon type valve arrangement by the operator after removing the grow bag. The valve is designed to open automatically at fixed plant to plant spacing of 1.52 m through ground wheel measuring system with the help of cam and lever. Seedlings are earthed up by a suitable shovel and finally the soil around the plant is compacted by the set of press rollers. The field capacity of the machine is 1.5 ha day^{-1}. The cost of operation of the machine is Rs. 3500 ha^{-1} whereas the cost of operation for the conventional method of planting is Rs. 18500 @ Rs. 6 $plant^{-1}$. The machine results in 50% saving in time and 90% saving in labour. The machine results in 81% saving in cost when compared to the conventional method. The cost of the machine is Rs. 50000.

Tractor Operated Small Seed Planter

A tractor (26.11 kW) operated six row planter has been developed for planting small seeds like that of onion.

It consists of inclined plate type metering mechanism, seed hopper for each row, shovel type furrow openers and three point hitch system. The capacity of the seed hopper is about 1.5 kg and metering plate of 130 mm diameter is made of plastic. The power to the metering mechanism is provided from the lugged ground wheel roller in front of the machine with the help of chains and sprockets. The row to row spacing of the machine is 150 mm whereas plant to plant spacing can be changed either by changing the plate with different number of notches or by changing the sprockets. To overcome the problem of depth control during seed placement, two rollers are fitted at the front (256 mm diameter) and rear (246 mm diameter) of the machine. The front roller has lugs and the power to the metering mechanism is provided from this lugged roller with the help of chains and sprockets. The unit is provided with 24 groove plate at forward speed of 2.0 km h^{-1}. The sowing can be done on beds having top width of 1 m to suit vegetable digger for digging the crop. There are savings of about 50.40% in cost of operation and 81.12% in labour as compared to traditional method of onion cultivation. The field capacity and cost of operation of the machine are 0.16 ha h^{-1} and Rs. 5090 ha^{-1}, respectively.

Tractor Operated Garlic Planter

A tractor operated six row garlic planter has been developed with actuating spoon (size of 23 mm diameter and 2.5 mm depth) type metering mechanism for planting of garlic at 150 mm row spacing to suit local seed varieties and agronomic practices. It consists of seed metering plate, seed hopper, agitator and seed covering device. The power to the metering mechanism is provided from the ground wheel with help of chain and sprockets. The garlic planter can be used for sowing garlic on 1 m wide beds. The field capacity of the machine varies between 0.18-0.21 ha h^{-1} at a forward speed of 2.00 to 2.25 km h^{-1}. An average percentage of missing and multiples are 9.13 and 26.70%, respectively with tractor operated garlic planter. There is saving of 82% in labour requirement and 57% in cost of operation as compared to manual planting. The approximate cost of the machine is Rs. 150,000 and cost of operation is Rs. 6168 ha^{-1}.

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Vegetable Transplanter (Plug type)

Tractor mounted plug type vegetable transplanter consists of main frame with hitching system, ground wheel, shoe type furrow openers, compaction wheel, operator's seats, two depth control wheels and plug type metering mechanism. The working width of machine is 1350 mm. The average field capacity of transplanter is 0.14 ha h^{-1} with field efficiency of 75% for chilli, tomato and brinjal at 450 mm row spacing.

Vegetable Transplanter (Picker wheel type)

A two row semi-automatic planter having picker wheel type metering mechanism has been developed to transplant the root wash type seedlings on the beds as well as on flat fields. Two persons (one for each row) are required to place the seedlings in the flappers when these open at the top position. After the seedling is dropped in the furrow, the soil is compacted around it with the help of two moving inclined wheels. Average field capacity of machine is 0.10 ha h^{-1} at forward speed of 1.0 km h^{-1}. The cost of operation with the machine is Rs. 2200 ha^{-1} as compared to Rs. 2800 ha^{-1} with manual transplanting.

Tractor Operated Hydro-Mechanically Controlled Mould Board Plough for Orchards

The operation of cutting of old roots and breaking of hard bed formed between inter spaces of adjacent trees take huge time and involves lot of human drudgery. By using conventional M. B. plough, it is not possible to break the bed and old root cutting in inter spaces between adjacent trees. The farmers necessitated the system for relieving them introducing mechanized faster operation for accomplishing such operation benefiting the new root formation and proper aeration to root zone of the trees. Advantage of such equipment is that due to use of hydro-mechanically controlled sensor mechanism, the bed in between two adjacent trees is broken without causing any damage to the trees. Hydro-mechanically controlled M. B. Plough has been developed to break the bed and old root cutting in inter spaces between adjacent trees. The main parts of equipment are main frame, two bottom plough with one bottom stationary and other plough bottom swinging, 60 litre capacity hydraulic oil reservoir, hydraulic pump, hydraulic hoses, control valves and sensor bar. The effective field capacity of the equipment is 0.07 ha h^{-1} with 71.18% field efficiency. The cost of operation is Rs. 7650 ha^{-1} and net saving is Rs. 3350 ha^{-1}.

Tractor Operated High Clearance Weeder

Most of the crops with tall morphology are planted in wide spacing of 600 to 900 mm. For weeding in crops after 45 DAS, the conventional cultivators cannot be used due to the low clearance below the frame. Hence, development of a tractor operated high clearance weeder is the need of the hour.

A tractor operated high clearance sprayer has been developed based on regional agronomical requirements suiting to cotton and maize crops for accomplishing efficient weeding for plant height up to 700 mm. Main frame is made up of mild steel square channel of 1070 x 2220 x 717 mm size. The frame is extended on both sides by 1070 x 785 x 717 mm frames to increase the width of coverage of the weeder. These extended frames are hinged to the main frame which facilitates the folding of extension frames during transportation of weeder in road condition. A 'C' type shovel of 60 mm width is fabricated and attached to the cultivator tynes. Sturdy rigid tynes, which do not deflect during the work in the field, have been attached to the shovel as weeding tool. The tynes are bolted between angle braces, fastened to the main bars by sturdy clamps and bolts. The spacing between the tynes can be changed simply by slackening the bolts and sliding the braces to the desired position. The depth of operation of the weeder can be raised and lowered by a three-point hitch. The performance of the weeder is good for tall crops with the row spacing of 750 mm and crop height of 650 mm at soil moisture content (dry basis) of 13-20%. It give average weeding efficiency, plant damage and field capacity of 88%, 3% and 0.65 ha h^{-1}, respectively. For wide row crops, three rows can be covered with three tynes in a row, whereas, if the row spacing is narrow, five rows with three tynes in a row can be covered. This weeder can be adopted for weeding even at crop age of 60 days.

Tractor Operated Banana Clump Remover

Banana crop is maintained for two years to get the benefit of two harvests. The crop needs removal of clumps (plants along with root portion) after two years. During the process of removal of the clump, the mother plant along with the rhyzome and side suckers as a whole mass has to be removed so as to prepare the land for the next crop. Manual labourers do this operation using crowbars and spades. A tractor operated banana clump remover has been developed by adopting frame of nine-

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tyne cultivator. Two sub-soiler shanks of size 100 x 15 x 1000 mm with shares of size 190 x 40 x 5 mm are fitted in the nine tyne cultivator frame at 225 mm spacing. These two sub-soilers perform as a fork for removing the banana clump. A deflector is provided to push the soil sideways. The equipment is attached to the 3-point linkage of a 26 kW tractor. The field capacity of machine is 0.5 ha h^{-1}. The cost of manual digging of the clumps is between Rs. 3000 and Rs. 3500 ha^{-1}. The cost of operation with the equipment is Rs. 1700 ha^{-1}. Thus, there is a saving of Rs. 1800 ha^{-1}.

Mechanization Gaps in Horticultural Sector in North Eastern Region

1	Horticultural hand tools	Small hand tools for various horticultural operations like grafting, pruning, harvesting, decortication, etc are needed for time and energy saving and drudgery reduction
2	Planting of fruit tree nurseries	Power tiller operated post hole digger (pit size 1×1×1 m size) for planting of seedlings of the horticultural crops in hilly terrains
3	Extension of growing season under cold climatic conditions	Protected cultivation technologies for cucumber, tomato, capsicum, cauliflower, cabbage, okra, roses, Gerbera and Lillium
4	Stacking system for vegetable crops like pea, tomato, beans, cucurbits, kiwi etc.	Develop/adopt the stacking systems
5	Pruning, canopy management and harvesting of fruit crops	• Develop/modify an improved ladder for pruning and harvesting of fruit crops for hill horticulture • Adoption/modification of pneumatic pruning secateurs/power secateurs • Develop/adopt pluckers for apple, mango, peach, apricot, walnut, aonla, chilgoza etc.
6	Plant protection in orchards	Low cost plant protection equipment having potential to spray tall as well as medium fruit trees with mist/fog type spray nozzles
7	Harvesting of ginger and turmeric	Develop/adopt harvesting equipment for rhizome crops, such as ginger, turmeric etc
8	Efficient irrigation systems for horticultural crops	• Drip and sprinklers irrigation techniques needs to be propagated for judicious and timely use of available water, especially for horticultural crops • Design of gravity fed water system of drip & sprinkler irrigation for hill horticulture
9	Nursery tools and devices	Development of tools/equipment for uprooting of fruit/forestry plants from nurseries
10	Weeding	Low cost weeding tools for food and horticultural crops
Polyhouse mechanisation		
11	Greenhouse designs	Develop/adopt design of polyhouses for varying slopes of hills
12	Protected cultivation for extension of growing season	Small poly houses for nurseries and cultivation of vegetables, flowers, etc. under controlled atmospheric conditions

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MANAGEMENT OF FALL ARMYWORM- AN ALARMING AGRICULTURAL CRISIS IN NORTH EAST INDIA

Arup Kumar Sarma
Biswanath College of Agriculture, Assam Agricultural University
Biswanath Chariali-784176
Email: ak_barbhagia@rediffmail.com

Fall Armyworm (*Spodoptera frugiperda*) is a pest native to tropical and subtropical regions of the America. The incidence of this pest was first observed in our country at Shivamogga, Karnataka on 18th May, 2018. Recently, it has also entered and attacked maize crop in several states of North East India. The ICAR Manipur Centre for the first time reported the incidence of fall armyworm in Manipur state in the month of May, 2019 (Firake *et al*., 2019). It has also alerted that the pest has already caused extensive damage to maize cultivation at Chandonpokpi, Chandel district. Accordingly, Manipur agriculture department has constituted three joint action teams to combat the spread of FAW. In Arunachal Pradesh, the pest has been identified in the campus of College of Horticulture and Forestry (CAU, Imphal), Pasighat during May itself. Mizoram government has informed the ICAR Centre about an estimated crop loss of Rs. 20 crore caused by an outbreak of FAW in the state. ICAR-NEH centre also expressed its concern and in its advisory stated that in addition to Mizoram, Nagaland, Tripura and Manipur, it has also been detected infesting maize fields in Meghalaya and also suspected to be in Sikkim too (Firake *et al*., 2019).

Food and Agriculture Organization (FAO) of the United Nations in its report has emphasized the invasiveness of Fall Armyworm (*Spodoptera frugiperda*) in recent times. It can attack more than 80 plant species, causing remarkable damage to economically important cultivated cereals such as maize, rice and sorghum, and also to vegetable crops and cotton. It is the larval stage of the insect that causes the damage of crops. It is high time to disseminate the techniques of controlling the pest. Agricultural officers, extension workers, farmers, agro-based NGOs and policy makers should be well aware of the biology and management tactics of the pest.

Why it is so Invasive? FAW is highly invasive for its short life cycle with several generations per year, high reproductive potential with high fecundity and strong flight capacity. It reproduces several generations per year. A female moth can lay up to 1000 - 1200 eggs in her life time. Being strong fliers, the moths can fly up to 100 km per night and can invade a large area within a small span of time.

Identification of Fall Armyworm: Identification of FAW is the first step for management.

a) The moth is 3 to 4 cm wide. Its front wings are dark brown while the rear wings are grey white. It will live 2 to 3 weeks and lay about 1000-1200 eggs before dying.

b) Eggs are pale green or white at the beginning, get covered in scales, and turn clear brown to brown before hatching. They hatch within 2-3 days.

c) Half-grown or fully grown caterpillars are the easiest to identify. The larvae are generally characterized by 3 yellow stripes on the back, followed by a black, then a yellow stripe on the side. Look out for four dark spots forming a square on the second to last segment. Each spot has a short bristle (hair). The head is dark; it shows a typical upside down (inverted) Y-shaped pale marking on the front. A larva sheds off its skin five times and passes through six stages before pupation. Young larvae are pale colored. They become brown to pale green, and then turn darker at the advanced stages. Depending on the season, the larval duration lasts for 12 to 20 days.

d) Pupae are dark brown and remain hidden in the soil, more rarely in the stalk. Pupae live for 12-14 days before they emerge as adults.

Symptoms of Attack: The caterpillars prefer to feed inside the whorl of a maize plant, where it feels protected and chews tender maize leaves. As they chew away, the leaves continue to grow out, and thus, leave a ragged/ half-chewed leaves that are typical symptoms of FAW infested maize fields. At very high population levels, FAW can also penetrate maize ears, causing direct damage to the harvest. They do not produce dead-heart (drying away of central leaves) as the stem borers do.

Management Strategies Against FAW: A strategic crop management practice along with systematic plant protection is essential in an area where FAW has established. Such practices should be applied in wide manner through community approach in order to manage FAW population below economically damaging levels. An integrated pest management (IPM) approach is to be followed as described below:

1. All farmers of a locality/community should plan to sow at same time (within 2-3 days of same week) to get uniform planting. The pest attacks crop with staggered planting more.

2. Deep ploughing of the crop field before planting in every crop season is essential to expose the hidden FAW pupae to sun light and predators. If zero-tillage is practiced, spread neem cake @ 500 kg ha^{-1}.
3. Plant napier grass in the border rows to act as FAW trap crop.
4. Single cross maize hybrids with tight husk cover should be selected for planting. Seed treatment might prevent early damage of the seedlings after germination.
5. Hill planting of maize is to be avoided; one plant should be maintained per hill by thinning.
6. Intercropping of maize with suitable pulse crops of particular region should be done for maximizing plant diversity. For example: Maize + pigeon pea/black gram /green gram.
7. Maintain the crop field clean, weed free and follow balanced fertilizer application.
8. After control measures, apply nitrogen and irrigation to boost the crop growth.
9. Spray the crop with 5% NSKE or azadirachtin 1500 ppm @ 5 ml l^{-1} at weekly intervals. Also release *Trichogramma pretiosum* @ 50,000 or *Telenomus remus* @ 10,000 adults $acre^{-1}$ at weekly intervals, starting within a week of germination till harvest. Commercial formulation of *Bt* (*Bacillus thuriengiensis* variety *kurstaki*) is also effective if applied @ 2 g l^{-1} water. These control measures are important for organic states of North East Indian states.
10. Install FAW pheromone traps @ 2 $bigha^{-1}$ on or before germination of the crop to monitor pest arrival and population build-up.
11. Use pheromone trap @ 6 $bigha^{-1}$ cropped area for mass trapping of male moths to keep population buildup under control.
12. Erect bird perches @ 10 acr^{-1} as soon as sowing is completed.
13. Follow weekly scouting and adopt symptom based control measures. One should follow the action thresholds for right timing of the chemical spray.
14. While scouting, hand pick and destroy egg masses and neonate larvae by crushing or immersing in kerosene water.
15. Timing of chemical control measures is based on action threshold. Action threshold determined is determined by leisure walking in "W" pattern in the field after leaving 4-5 border rows. Observe 10 plants in each of the five stopping points of "W" pattern (starting point+3 vertices of the three angles in the "W" + the finishing point) and record the number damaged plants of the 50 plants observed in one "W" scout to find out percent of plant infested. At early stage the spray should be done at 5-10% infested plant and at later stage, at 10-20% damage. Insecticides like spinectoram 11.7% SC @ 0.5 ml l^{-1} or chorantraniliprole @18.5 SC @ 0.4 ml l^{-1} or thiamethoxam 12.6% + lamda cyhalothrin 9.5% ZC @ 0.25 ml l^{-1} of water may be applied.
16. Poison baiting of large size FAW larvae: Pesticides sprays often fail to control 5th and 6th instar larvae and poison baiting is the most effective at this stage. To prepare the bait:
    a) Mix 10 kg rice bran and 2 kg jaggery in 2-3 litres of water.
    b) Keep the mixture for 24 hours for fermentation.
    c) Add 100 g thiodicarb 75% WP.
    d) Roll the mixture into small balls of 0.5 - 1 cm diameter just half an hour before application in the field. Add some sand while rolling if the balls are too sticky.

The above mixture is sufficient to cover about 2.5 bigha of cropped area. The bait should be applied into the whorl of the plant in the evening.

Precautions

1. Use gloves and mask while preparing and application of poison bait and pesticide spray.
2. All the pesticides spray and poison bait should be applied only to the whorls.
3. Enter the field only after a minimum period of 48 hours followed by a pesticide spray.
4. Avoid cattle grazing in pesticide sprayed and poison baited fields at least for a month.

Sound policy at state level should be formulated and implemented to prevent its entry and management should be done before it causes enormous damage to crops.

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STATUS AND PROSPECTS OF MITHUN FARMING IN NORTHEAST INDIA

Vivek Joshi, Kamni Paia Biam, J. K. Chamuah, R. Vikram and M. H. Khan
ICAR-National Research Centre on Mithun, Medziphema, Dimapur, Nagaland 797106
Email: joshignet@gmail.com

The northeast region of India is a hotspot for a rare bovine species, *Mithun* or *Gayal* (*Bos frontalis*). It is an important endemic species mainly found in forests of northeastern hilly states and neighboring countries like Myanmar, Bhutan, Bangladesh, Yunnan (China), Thailand and Malaysia. In India, mithun is considered not just an animal but a matter of pride, status, taste, values and preference. It is exclusively reared by indigenous tribes of Arunachal Pradesh, Nagaland, Mizoram and Manipur. Mithun is popularly known as *'Cattle of Mountain'* and needs a habitat of dense and evergreen hilly forest to thrive. With a narrow geographic range and small population, at present, mithun is considered a species vulnerable to extinction. Mithun plays a central role in socio-economic and cultural life of tribal people. It is the state animal of Nagaland and Arunachal Pradesh. The official emblem of Nagaland government depicts a majestic mithun standing on a green hilly landscape. In this insignia, mithun is a symbol of health and wealth of Nagas. In Assamese, mithun is called *'Methon'*, it is called *'Eso'* or *'Hoho'* or *'Sebe'* in Arunachal Pradesh, the Mizos call it *'Sial'*, it is called *'Sandong'* in Manipur and *'Wei'* and *'Seizang'* in Naga tribes. Mithun farming is an important activity intrinsically linked to sustainable livelihood in northeast India.

Origin of Mithun

This is quite complex and ambiguous. It is believed that approximately 6-8 thousand years ago, mithun originated in India-Myanmar frontier areas, however, no information is available on its domestication for the first time. At present, there are three major but conflicting hypotheses on origin of mithun. In the first hypothesis, it has been postulated that mithun originated from direct domestication of wild gaur (*Bos gaurus*). This is the most widely accepted assumption and is well supported by similar appearance of mithun and gaur. The second hypothesis presumes mithun is a hybrid originating from cross-breeding between wild gaur and domestic cattle (*B. indicus* or *B. taurus*). The third hypothesis assumes that mithun originated from a wild bovid which is now extinct. However, till today, none of the hypotheses has been proven conclusively. A recent study at ICAR-National Research Centre on Mithun, Nagaland revealed a common origin of mithun and wild gaur from an ancient and extinct bovine species based on mitochondrial genome sequencing.

Population of Mithun in India

According to 20th livestock census (2019), mithun population has shown a growth rate of 26.66% over the preceding census (2012). Currently, total mithun population in the country is 0.38 million. Between 2012 and 2019, male population of mithun grew at a faster rate (30.76%) than female population (23.52%). In India, total male and female mithun population is 0.17 and 0.21 million respectively. Arunachal Pradesh (0.35 million) has the highest mithun population followed by Nagaland (0.023 million), Manipur (0.009 million) and Mizoram (0.004 million).

Behavioral and Morphological Characteristics of Mithun

Mithun is a majestic ruminant inhabiting hilly forests at an altitude of 1000-3000 m. It is a mammalian species belonging to family bovidae and order ungulate (hoofed mammal). This large herbivore is capable of browsing efficiently even in steep hilly slopes and does not require pasture land like other bovine species. The farmers rear mithuns in forests under free grazing system where they eat a variety of grasses, tree leaves and young plants. They do not offer other feed and fodder to mithuns, however, occasionally feed salt to mithuns especially when they need to be restrained. Mithun has a great

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liking for salt feeding. In general, mithuns are reared in forests in community herds where mithuns of different owners graze together. The forest areas are often fenced and few herdsmen are appointed by village council for supervision of mithuns in the forests during daytime and bringing them back to the village at night. Mithun is a selective browser, travels for long distance in forests in search of fodder and consumes up to 30 kg day^{-1}.

Mithun is mainly reared for meat purpose. It is often slaughtered for high quality organic meat during marriage ceremonies, religious festivals, elections and community feasts. Therefore, mithun is popularly known as *'Ceremonial Cattle'*. Mithun is regarded as a last resort of money and sold by poor farmers at the time of adversity to fulfill money requirement for children's education and health emergencies. It is also used for barter trade purpose apart from being used for paying fine, ransom and price of bride by groom's family (bridal gift) (**Fig. 1**).

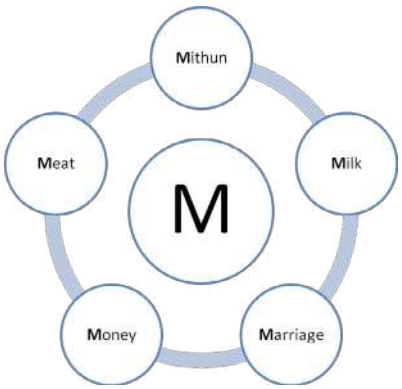

Fig. 1 5 'M' of Mithun Farming

From ancient times, it is believed that mithun is related to indigenous tribal culture and in some folklores, mithun is regarded as descendant of sun. Mithun plays an important role in social, economic and cultural life of tribal population. Mithun ownership is still considered a symbol of prestige and prosperity in northeast India.

Mithun is very shy in nature and a medium to large sized ruminant species which in external appearance resembles domestic cattle and buffalo. The visual appearance of mithun is similar to wild gaur (also called Indian bison) except for the body shape and horns. Mithun is smaller in size than gaur while its horns are more or less straight in comparison to curved horns of gaur.

In general, mithun is characterized by a big head, heavy body and strong legs. The forehead is usually broad and concave. Mithun is found in various body colors but black is the most abundant color. The jet black body with ash colored forehead and white stockings in all the legs is a characteristic feature of typical mithun. However, white stockings develop and become visible in mithun calves only after four months of age. The newborn calves are golden yellow and brown in color, however, as the age advances, adults become jet black to dark brown colored. The hump is absent in mithun and also, its tail and legs are smaller in comparison to domestic cattle. The ears are broad and dewlap is large sized in mithun. The average body weight of adult mithun aged 4-5 years is usually 400-500 kg. The maximum life span of mithun in India is recorded to be 15 years. The healthy and sexually mature mithun female periodically undergoes an estrus cycle of 19-24 days until it gets pregnant. During estrus, mithun female comes into heat but it does not exhibit clear signs of heat. Therefore, it is known as 'Silent Heat' and quite difficult to identify a mithun female in heat based on visual signs. Mithun does not prefer a definite season for breeding and a healthy adult mithun can breed throughout the year. The average age of puberty is 18-24 months and the breeding age of mithun bulls is 3-4 years. The gestation length is 270-290 days and normally, it gives birth to one calf at a time. The newborn mithun calf often weighs 18-25 kg.

Diseases of Mithun

Mithun is quite sturdy with an extraordinary ability to withstand various pathogens and diseases. Foot and mouth disease (FMD) is a common disease in mithun. It is a highly contagious and fatal viral disease. The infected mithun develops signs of fever followed by swelling of limbs, wounds in feet, excessive salivation, ulcers in tongue, gums and lips, limping, abortion and high mortality rate. To date, no treatment is available for FMD, thus, it is advisable to vaccinate newborn calves at 4 months of age and repeat it every 6 months before monsoon season. Other major diseases of mithun include hemorrhagic septicemia (HS), black quarter (BQ), tick and leech infestation, nematodiasis, Johne's disease (JD), pneumonia, anthrax, coccidiosis, etc.

Economic Potential of Mithun Farming

To date, potential of mithun to produce meat, milk and leather is not fully explored and it remains as an underutilized animal in northeast India. It is a need of the hour to use mithun more for commercial than cultural purposes. Mithun farming has now become an important source of income. There exists a great scope to promote mithun farming as a valuable source of organic meat and milk. Also, mithun possesses immense potential for use as draught purpose animal in hilly tracts.

Mithun is an efficient converter of forest biomass into superior quality meat. The meat of mithun is softer and better than other available sources of meat. Being low in fat, mithun meat is good for human health. There is a very high demand and preference of mithun meat among indigenous tribes. It is always

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advisable to slaughter mithun at the age of 4-5 years in order to get the highest amount of meat. Generally, the dressing percentage in mithun is 58-62%.

At present, consumption of mithun milk is unacceptable among tribal people and regarded as a taboo. Mithun can produce 1-1.5 kg day^{-1} of milk. Mithun milk is thicker and more nutritious than milk of other domestic animals. It is rich in fat (8-13%), solids-not-fat (18-24%) and protein (5-7%). Based on energy value, 1 kg of mithun milk is equal to 2 kg of cow milk. High lactoferrin, an antimicrobial compound in mithun milk, is associated with its medicinal property. Moreover, with technological intervention, mithun milk can be exploited to produce superior quality dairy products like cheese, curd, ghee, rasgulla, etc. due to its high protein content. Therefore, there is a need and extensive scope to promote mithun as a milch animal in northeast India. The spread of awareness in tribal population regarding milking of mithun (**Fig. 2**) and sale and consumption of mithun milk could be useful in poverty alleviation and improvement of economic status. Mithun milk provides nutritional security to poor farmers of northeast India.

The leather processed from skin of mithun is of superior quality due to its toughness and long life. This unique mithun leather has ample scope in tanning industry for production of expensive goods like bags, purses, jackets, shoes, etc. which can fetch a very high commercial value in national and international markets.

Being a hardy and sure-footed animal, mithun is well suited for draught and pack purpose on steep slopes of hilly areas. Due to its outstanding work power, mithun could be used for various agricultural operations, land management and pulling carts in hilly landscapes (**Fig. 3**). Thus, multi-dimensional mithun farming is important for socio-economic development of tribal population of northeast India.

Fig. 2 Milking potential of mithun

Fig. 3 (a) & (b) Draught and pack potential of mithun

Future Prospects of Mithun Farming

Over the last few decades, increased deforestation is constantly leading to a decline in mithun population in northeastern states of India. Moreover, declining population has increased the risk of inbreeding in mithun. Today, considering the socio-economic importance of mithun in tribal culture, special attention is being given to mithun conservation. The need at the moment is to bring free-ranging mithun under semi-intensive system and promote this scientific method of mithun rearing among indigenous tribes (**Fig. 4**). At present, efforts are made to popularize semi-intensive system and controlled mithun breeding. Semi-intensive mithun farming is promoted as a profitable venture to sustain livelihoods of poor farmers. Under semi-intensive system, adequate care, appropriate treatment and ample protection can be given to mithun calves, pregnant females and sick mithuns and hence, mortality rate can be minimized. For this, mithun sheds need to be built where mithuns can be housed at night time once they return from jungles after grazing during daytime. Furthermore, these sheds require availability of fodder and drinking water. This semi-intensive farming enables detection of mithun females in heat and breeding with superior bulls. Likewise, artificial insemination (AI) is another emerging technique in mithun husbandry and is considered important for future breeding policies of mithun along with estrous synchronization. Lastly, development of new drugs and vaccines is regarded as one of the useful tools in mithun conservation apart from improved methods of disease prevention and control.

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(a) Housing

(b) Feeding

Fig. 4 (a) & (b) Semi-intensive system of mithun rearing

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6

CONSTRUCTION OF SOME TRADITIONAL STRUCTURES FOR GRAIN STORAGE

Chingtham Chanbisana, R. Lalrinfeli and H. Prasad
College of Horticulture (CAU, Imphal), Thenzawl, Mizoram
Email: chanbi.sana44@gmail.com

The main occupation of Indian population is agriculture for the production of cereal and rice. If the grains are not properly stored, there will be deterioration. The moisture content determine the extent of deterioration while temperature, oxygen supply, characteristics of grains and infestation with moulds and insects also contribute to deterioration. Grains are in dormant condition, in storage, but continue to respire producing heat, water and carbon dioxide which usually facilitates the growth of moulds which are invariably present in the grains. The growth of moulds produce many enzymes that causes chemical deterioration of grains. So the storage of food grain is very important in our country.

Traditional Storage Structures

The different designs of storage structure depend on the nature of the grain, length of storage, prevailing climate, soil, level of storage (farmer, cooperatives national level) and quantity of storage which are discussed as follows:

1. Puri (straw storage structure)

This structure is constructed using freshly threshed paddy straw. The paddy straw is wound in the form of rope approximately of 100-150 mm diameter. The length of each rope is normally 6 m but all ropes are connected to each other. The structure is constructed on a consolidated earth and straw ropes are to prevent direct contact of paddy with the ground. These straw ropes are wound concentrically to form a circular wall of the structure and raised to a height, depending upon the capacity required. The loading and the construction are done simultaneously. The paddy straw ropes are secured by means of loose straw placed on the ropes as and when the layer/rings are being formed. This will prevent the paddy from flowing out of the structure. After loading the paddy, the structure is covered with paddy straw to form a conical roof, sometimes one or two circular straw ropes are placed on the roof to

withstand heavy winds and smaller diameter ropes are wound at the bottom to avoid bursting of the structure due to excess pressure of the grain. In some places, the structure is plastered with mud or cowdung on the outer surface to give some protection against fire hazards.

This structure can hold 3-20 MT of grain. This is purely seasonal one. It is generally constructed after the harvest and lasts for a period of 5-6 months. Paddy needs to be removed before the onset of monsoon season. The grain is well aerated because of the cross ventilation provided by the structure, retaining the original appearance/lustre of paddy and fetch a better price. This structure provides a good thermal insulation but this structure is not insect proof, not gas tight to carry out disinfestations measures and moisture proof.

2. Kotlu

These bulk storage structures are predominantly used for paddy storage. They are usually rectangular or square and constructed away from the living quarters or as a part of the living quarters wherein one of the rooms is designed for usage both as a store house as well as a living room when not used for storage. The kotlu are constructed either with brick walls or wooden planks.

Kotlu with wooden walls have an elevated floor and the ground below the floor of kotlu is usually

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cemented. The floor consists of palmyrah beams and bamboo poles and mud mortar. The palmyrah beams are used as main beams and bamboo poles are used as intermediates beams. The gap in between the bamboo poles is filled with algae (moss) to avoid the leakage of mud plaster. The whole floor is plastered with mud. Sometimes the whole floor is constructed with palmyrah beams only placing them closer to each other and then plastering with mud after filling the gap with algae.

Brick kotlu have the floor of granite slabs or it might be just cement plaster after compacting the earth with sand and brick pieces or concrete. Lime mortar and cement mortar (2:5) is used for the construction with the wall thickness varying from 450-600 mm. It is believed that brick walls without plastering and brick masonry wall plastered with cement mortar and again coated with mud plaster would give protection against the fungal damage.

The capacity of the structure varies in the range 7.5 - 30 MT. The annual maintenance of kotlu constructed with brick is very little. A split door with wooden planks is provided instead of single door for easy loading. An opening is also provided at the top for final loading. The life of the kotlu is reported to be about 20 years and above based on the type of material used for construction. If constructed properly, this is a good bulk storage structure for paddy storage. Although it does not give adequate protection against rats and moisture. Insect infestation is a common feature due to the resident infestation in the cracks and crevices as the inner walls are not plastered.

3. Gade/Gummi/Borem (bamboo/reed storage)

In areas where bamboo is available, the structure constructed with bamboo splits otherwise it is constructed with a local variety of reed/ cane. This structure is usually circular, sometimes hexagonal, in shape which is divided into two or three compartments. The outdoor gade has an elevated floor which is supported by stones and brick pillars. The palmyrah tree splits are used as main beams and bamboo poles are used as secondary beams and the gap between bamboo splits is filled with algae and mud and the whole is plastered with mud. Sometimes the floor is constructed with palmyrah beams only, placing them closer and plastering with mud after filling the gap with algae. In most of the cases, wall is of bamboo netting or local variety of cane netting with mud plaster on both sides. This bamboo netting acts as reinforcement. Sometimes the gade can be arranged inside the house. The capacity of an outdoor gade varies from 2-50 MT. Under normal conditions with proper maintenance, the life of the structure varies from 10-15 years but may last 4-5 years if not maintained properly. The lustre of the paddy grain stored in these structures is maintained even at the end of one year. This structure is easily susceptible to rodents and termites and is not suitable for fumigation and disinfestation. This structure can be moved easily due to its small size. The plastering of this structure with cowdung or mud plaster will not only prevent pilferage but also make the structure functionally gas tight to carry out fumigation.

4. Jadi (earthern structure)

Village potter is capable of making this type of structure. Black cotton soil is used for making the structure. The shape varies from place to place but is generally cylindrical. The structure may be of single piece of three or four pieces/rings joined and the joints are plastered with mud. Normally, the structures are burnt to get desired strength. The structure being fragile lasts till it breaks. However, structure as old as 20-30 years have been seen. Grain meant for seed purpose can be stored well without much loss in viability of the grain. Being fragile, it cannot sustain impacts and rat damage may be found in structures which are not burnt.

5. Pathra (underground storage structure)

It is a shallow underground structure for storage of paddy where the depth varies from 600 mm to 900 mm depending upon the water table of the area. After digging the pit of the desired capacity, paddy

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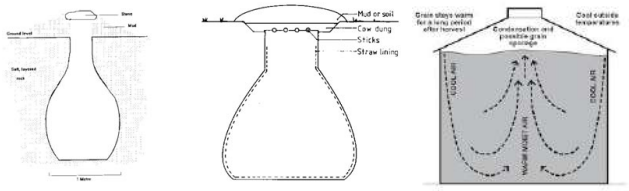
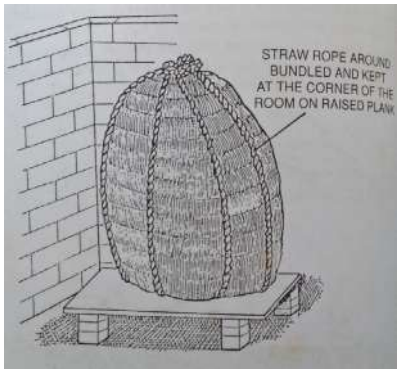


straw, paddy husk or palmyrah leaves are arranged at the bottom to prevent direct contact of the soil and paddy. After filling the structure with paddy to the ground level it is covered with palm leaves or paddy straw and is packed with earth to form a conical shape which is done to prevent the entry of rain water into the structure. Unloading is done after removing the top layer of mud, straw and palm leaves. Normally, paddy stored in this structure is removed before onset of monsoon to avoid moisture damage. This structure is not a permanent one and constructed every year in dry regions. Capacity varies from 1-2 MT. Cost of construction is low and there is no fire hazards but it does not provide protection against moisture damage.

The usual practice is to clean and whitewash the floor and walls and burn some straw and close the lid to take care of any residual infestation. After filling the grain, neem leaves are spread at the top. The structure can be made functionally gas tight if the top is sealed. Because of the small size of the structure, they do not occupy much space.

6. Basta (Hessian Storage Structure)

These are gunny bags made out of hessian or jute or mesta fibre. The jute bags used are usually of 'B' twill type but some farmers use hand knitted mesta (Hebiscus cannabis) bags depending upon their economic condition. Grains meant for seed purpose is generally stored in bags. The weave clearance of hand knitted bags is very close which prevents cross infestation to some extent. The capacity of each gunny bag is about 75 kg of paddy or a quintal of cereals or pulses. The grain kept in bags is well aerated and is preferred for storing seed paddy. The structure cannot be disinfested with out the use of gas proof sheet. Since they are liable to be damaged by rats or while handling with hooks, frequent replacement is needed.



7. Kottai

This is a straw storage structure which is constructed in the form of a large bundle tightly secured by means of paddy straw ropes both horizontally and vertically. Sometimes they are plastered with cowdung. They are placed on a stone or a raised platform in one corner of the house. Paddy meant for seed purpose are generally kept in this type of structure. The capacity of the structure varies from 50 - 100 kg depending upon the need of the farmers. The structure is constructed every year and grain is stored in these structures for one year. The structure is not rat proof and if proper care is not taken, considerable quantity of previous seed paddy is lost. The structure is not fire proof.

Conclusion

One may go for the construction of such traditional cheap structures in villages for storing paddy or cereal for short term preservation purpose. It provides an easy storage system for common farmers who cannot afford expensive storage structures even though the lifespan of these storage structures may be short depending upon the material used for the construction. Inspite of the disadvantages of these structures, it meets the purpose of storage of grain for the common farmers, provided certain care is taken, since the cost of construction is also low and it is farmer friendly too.

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7

JACKFRUIT – A FUTURE VERSATILE CROP INTRODUCED IN ARUNACHAL PRADESH

B. N. Hazarika
College of Horticulture and Forestry (CAU, Imphal)
Pasighat -7911102, Arunachal Pradesh, India
Email : bnhazarika13@yahoo.co.in

Jackfruit is a versatile plant that provides food, timber, shade, fodder and medicinal and industrial products. Though it is believed to be indigenous to the rain forests of the Western Ghats, India, it has been cultivated in many parts of the tropics, particularly in the South-East Asian region since time immemorial. In North-eastern India, the leading jackfruit producing states are Tripura, Meghalaya, Sikkim, Manipur and Assam. The states of Assam and Tripura produces considerable share of jackfruit in India and the total annual production in Assam is estimated to be around 1,75,000 tones (APAARI, 2012). The area under jackfruit cultivation in homestead gardens of Tripura is approximately 2,200 ha with production of 12,500 MT (Singh *et al.,* 2018).

Versatile fruit- jackfruit

It is one of the fruit plant entered into wider cultivation through a farmer-driven domestication process because its products meet the household needs of families with limited land, which require wood and animal feed to ensure family food security. The jackfruit tree is a wild plant throughout the tropics and subtropics as it bears the largest known edible fruit up to 35 kg (Purseglove, 1968; Rowe-Dutton, 1985). However, its cultivation is mostly confined to homestead gardens having one or two plants as backyard crop. Large scale commercial cultivation or cultivation in the form of orchards are rarely seen in whole North East other than Tripura to some extent. In Arunachal Pradesh, it is only seen as roadside plants or sometimes in jungles. Considering the jackfruit as one of the futuristic crop because of its potentialities and ease of cultivation a jackfruit orchard has recently been established in College of Horticulture and Forestry, Pasighat farm, introducing some elite clone of Jackfruit collected from Assam for systematic research in jackfruit which will be a first orchard of jackfruit for systematic research in future. A brief about the crop and crop husbandry are discussed in this article.

Uses of Jackfruit

The young fruit is cooked as a vegetable, which has good demand in lean period of other vegetables. Besides, pickled or canned in brine; pulp of ripe fruit is eaten fresh or made into various delicacies like jam, jelly or preserved as candies by drying or mixing with sugar, honey or syrup. The edible bulbs of ripe jackfruit are consumed fresh or processed into canned products. Seeds make-up around 10 to 15% of the total fruit weight and have high carbohydrate and protein contents (Bobbio *et. al.,* 1978; Kumar *et al.,* 1988). The seeds are eaten after boiling or roasting, or dried and salted as table nuts, or ground to make flour which is blended with wheat flour for baking. Jackfruit is a nutritionally rich fruit crop. Some physicochemical and rheological properties of jackfruit seed flour and starch, isolated from the flour is given in **Table 1** (Tulyathan *et al.,* 2002).

Table 1 Composition and some physicochemical characteristics of jackfruit flour (% dry weight basis, except moisture)

Properties	% (dwb)	
	With brown spermoderm	Without brown spermoderm
Moisture	7.70 ± 0.20	8.57 ± 0.25
Crude protein (% N x 5.7)	11.02 ± 0.46	11.17 ± 0.21
Crude fiber	2.36 ± 0.04	1.67 ± 0.11
Total Carbohydrate	81.64	82.25

Source: Tulyathan *et al.* (2002)

It is also reported that the jackfruit pulp is one natural source of antioxidant compounds. The antioxidant capacity of jackfruit (*Artocarpus heterophyllus* Lam. Fam. Moracae) fruit pulp (JFP) obtained from Western Ghats India was determined by evaluating the scavenging activity using 1,1-diphenyl-2-picrylhydrazyl (DPPH), ferric reducing power assays andN, N-dimethyl-p-phenylendiamine (DMPD) radical cation decolorization assay. JFP was analyzed for total phenolic content (TPC) and total flavonoids content (TFC).

The ethanol and water are the best solvents for the extracting phenols and flavonoids from the JFP. The antioxidant activities of JFP extracts were correlated with the total phenolic and flavonoids content (Jagtap *et al.,* 2010). The recommended processing conditions for maximizing firmness, L value and overall acceptability and minimizing juice leakage, and browning index in the samples at the end of 20 days of low temperature storage were found to be 1% $CaCl_2$, 0.02% AA, and 30 min of treatment time. The RSM was found tobe an effective tool to model the effect of minimal processing treatments on jackfruit bulbs quality (Saxena *et al.*, 2012). A study was undertaken by Goswami *et al.* (2011) to determine the physical properties and chemical composition of three types of jackfruit (*Khaja, Dorasha* and *Ghila*) pulps collected from different growing areas (**Table 2**).

Table 2 Biochemical parameters of pulp of Jackfruit collected from different growing areas

Types of Jackfruit	Moisture (%)	Dry Matter (%)	Ash (%)	Vit C (mg %)	Carotene (µg 100 g^{-1})	Starch (%)	pH
Valuka Khaja	82.88	17.12	0.98	5.20	334.06	7.37	6.29
Valuka Ghila	84.44	15.56	1.04	7.26	470.91	6.11	5.93
Valuka Dorosha	80.04	19.96	1.11	8.18	380.45	7.07	5.82
Modhupur Khaja	80.95	19.05	0.88	4.57	346.03	8.34	6.45
Modhupur Ghila	79.62	20.38	0.70	7.13	520.46	7.27	5.61

Contd. table

Protein (%)	Titrable Acidity (%)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	TSS (%)	Fibre (%)
0.57	0.79	13.80	4.92	8.88	20.1	0.55
0.67	0.91	15.27	7.10	8.17	19.3	0.60
0.91	0.64	11.29	4.90	6.39	27.0	0.61
0.83	0.46	16.50	7.04	9.46	23.8	0.90
0.97	0.61	17.89	8.19	9.70	26.4	0.51

Fig. 1 & 2 Newly established jackfruit orchard at CHF, Pasighat

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Fig. 3 One year old plant start flowering

Other Uses Jackfruit

Feed: Jackfruit is a good cattle feed. Surplus jackfruit rind is considered a good stock food.

Leaves: Young leaves are readily eaten by goat and other livestock. The leaves are used as food wrappers in cooking, and they are also fastened together for use as plates.

Latex: The latex serves as birdlime, alone or mixed with *Ficus* sap and oil from *Schleichera trijuga* Willd. The heated latex is employed as a household cement for mending chinaware and earthenware, and to caulk boats and holes in buckets.

Wood: Jackfruit tree is an important timber. It changes with age from orange or yellow to brown or dark-red; is termite proof, fairly resistant to fungal and bacterial decay, seasons without difficulty, resembles mahogany and is superior to teak for furniture, construction, turnery, masts, oars, implements, brush backs and musical instruments.

Bark: There is only 3.3% tannin in the bark which is occasionally made into cordage or cloth.

Medicinal: The seed starch is given to relieve biliousness and the roasted seeds are regarded as aphrodisiac. The ash of jackfruit leaves, is used alone or mixed with coconut oil to heal ulcers. The dried latex yields artostenone. The root is a remedy for skin diseases and asthma. An extract of the root is taken in cases of fever and diarrhea.

Varieties of Jackfruit

There are few important varieties released from various institutes. A brief description of the varieties are given here under.

Singapore (or) Ceylon jack: It was introduced from Sri Lanka. Fruits are medium in size each weighing more than 7 kg.. The carpels are crisp, sweet, yellow with strong pleasant aroma. It is a precocious bearer *viz*., even seedling progenies will start bearing from 3 years after planting

Hybrid jack: It is a cross between Singapore jack x Velippala developed at Fruit Research Station, Kallar, Tamil Nadu. Trees are precocious in bearing.The trees are medium in height and prolific in bearing.

Konkan prolific: It is a selection released from Dr BSKKV, Dapoli, Maharashtra. Growth habit is semi spreading and fairly large with leaves dark green and alternate. The tree is monoecious with small male flowers held by pedicel. Female flowers are larger than the male and pedicel is thick. The fruit contains the edible, sweet, aromatic, crispy bulbs.

PLR-1 (Palur-1): It is a variety developed at Vegetable Research Station, Palur of Tamil Nadu Agricultural University. A single plant selection isolated in Panikkankuppam village near Panruti of South Arcot District of Tamil Nadu. The fully ripe fruits have flat stigmatic surface instead of a spiny surface. Each tree bears about 60-80 fruits. The average fruit weight is 12 kg.

PPI-1 (Pechiparai-1): It was developed at Horticultural Research Station, Pechiparai of Tamil Nadu Agricultural University by clonal selection from Mulagumoodu local. Trees are medium tall, maximum bearing in tree trunk. On an average, each tree bears 107 fruits weighing 1818 kg y^{-1} in two seasons, *viz*., April – June and November – December. Suitable for commercial planting as well as for planting in home garden.

Propagation of Jackfruit

Seed propagation is common method of propagation in jackfruit. Being highly heterozygous and cross pollinated, it has resulted in immense variation among populations for yield, size, shape, flesh colour, quality of fruit and maturity period. The significance of vegetative propagation in the maintenance of genetic uniformity and preservation of identity of an elite clone or cultivar is well recognized in horticultural crops (Aralikatti, 2005). In grafting, attached method of grafting like approach grafting has shown greater success (Nazeem *et al*., 1984). In jackfruit conventional vegetative propagation methods like budding, grafting air layering etc., are generally cumbersome, time consuming and highly season bound with low multiplication rate. Further budded or grafted trees are not of much value for timber as the trunks do not retain their natural

shape. The experiment on softwood grafting revealed that among different aged rootstocks, seven months old root stocks recorded the highest graft success (51.90%), and more number of leaves (52), 90 days after grafting. Significantly more number of sprouts (2.33) and longer sprouts (4.32 cm) were recorded in case of four months old root stocks (Aralikatti, 2005).

Cultivation of Jackfruit

Planting: Pit size of 1 m x 1 m x 1 m should be made and filled up with top soil mixed with 10 kg of FYM and 1 kg of mustard cake/ neem cake per pit. Grafted plants preferably planted during June - December at 8 x 8 m spacing. The planted in the centre of the pits during June - September. Proper staking is required to avoid lodging and subsequent breakage at graft joint. Providing shade with leaves and thorough mulching of basins after the monsoon season are essential to avoid mortality of grafts.

Training and manuring: Jack trees are generally trained to a single stem, early side branches should be removed so that a uniform smooth trunk develops for a height of 1.5 - 2 m and then side branches should be permitted to arise. The flower buds appear on trunk which should be kept free of vegetative growth. A general recommendation of manure and fertilizer dose are as follow:

Manures & fertilizers (kg)	1 year old	Annual increase	6th year and above
FYM	10.00	10.00	50.00
N	0.150	0.150	0.750
P	0.080	0.080	0.400
K	0.100	0.100	0.500

The fertilizers are applied during rainy season. If irrigation is available, they can be split into two doses and applied twice in a year i.e., during June - July and September - October. The manures and fertilizers can be applied in a circular trench taken 50-60 cm away from the trunk.

Irrigation: In general, jack is cultivated under rainfed conditions, but it is very sensitive to drought. Hence, irrigation should be done depending on the type of soil, season, etc., so that, there should not be any moisture stress, especially during flowering and fruit set. Likewise, too much of water will affect the quality of fruit. During the pre-bearing age, pulses can be raised as intercrop and mulch for moisture conservation.

Trees raised from seed start flowering at the age of 2-8 years. Clonally propagated trees produce fruit within 2-4 years from planting under favourable conditions. Clonal material reaches full production in Malaysia when the trees are 8 -15 years old. In suitable environments, jackfruit trees bear flowers and fruits throughout the year, but usually there is a major harvest period, in April-August or September-December in Malaysia, January-May in Thailand and in the 'summer' in India. This implies that 3-6 months earlier, conditions were particularly favourable for flowering or fruit set. Nath *et al.* (2002) observed that imbalance in soil moisture after fruit set leads to initial fruit drop and at flake formation stage leads to fruit cracking. Mulching with grasses/paddy straw/organic waste has shown marked effect on fruit set and fruit growth in jackfruit under eastern Indian condition.

Adaptation: Jackfruit thrives well and gives good yield in warm humid climate of hill slopes and hot humid climate of plains. The crop grows successfully from sea level upto an elevation of 1200 m at an optimum temperature range of 22 - 35°C. However, it cannot tolerate frost or drought. The yield and quality of fruits are medium under low humidity. The West coast plains with high humidity are found to be highly suitable. A deep rich alluvial or open textured loamy soil or red laterite soils with slightly acidic condition (pH 6.0 – 6.5) with good drainage is ideal for jack fruit , however, it can come up in variety of soils.

Plant Protection

Pests: Brown weevil (*Ochyromera artocarpi*): It bores into the tender buds, shoots and fruits.

Management: Destroying fallen fruits and buds, collection and destruction of grubs and adults and spraying the trees with monocrotophos (0.035%).

Spittle bug: Spray methyl parathion 50 EC 2 ml l^{-1} or methyl demeton 25 EC @ 2 ml l^{-1}. or phosphamidon 40 SL 2 ml l^{-1} or dust methyl parathion 2 D or quinalphos dust 1.5 D.

Diseases: Fruit rot (*Rhizopus artocarpi*): It causes premature fall of young fruits due to rotting and may result in heavy loss in yield under very humid conditions.

Management: Spraying dithane M 45 (0.2%) or bavistin (0.05%) or fytolan (0.2%) at 15 day intervals during fruit growth.

Rhizopus rot: Spray 1% bordeaux mixture or copper oxychloride 2.5 g l^{-1}. Three sprays must be given at 15 day intervals.

Harvest and Yield

Normally, jack starts producing fruits from 7th year onwards. However, grafted plants start to yield from 4th onwards. In Singapore jack, even seedlings start bearing from 3rd year. Normally, the fruits will be available from March to June. In higher elevation harvest extends upto

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September. Even in plains certain genotypes bear an off season crop during October - December. The yield ranges from 20 to 150 fruits tree^{-1}. The fruit weight varies from 2 to 20 kg.

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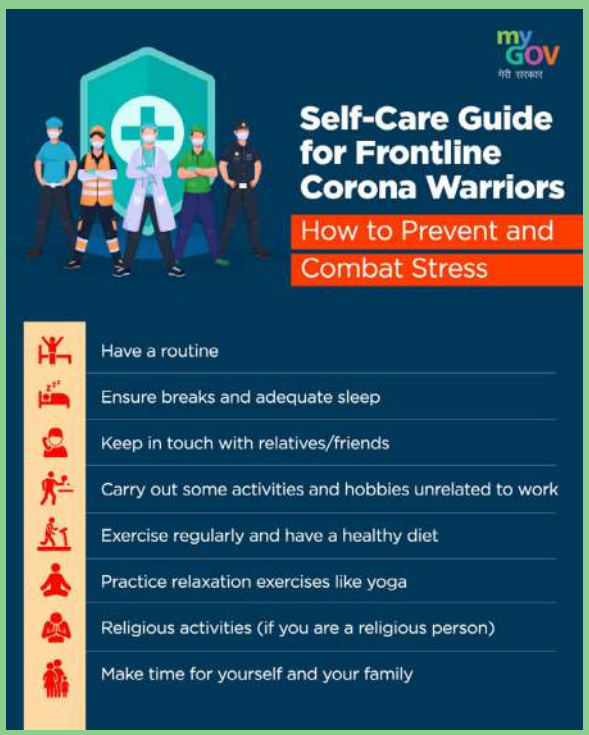

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MAIZE –FRENCH BEAN INTERCROPPING SYSTEM – FARMERS' WAY OF IMPROVING SOIL HEALTH IN NAGALAND

Harendra Verma[1], Shisarenla Aier[2], Christy Sangma[1], Romen Sharma[1] and D. J. Rajkhowa[1]
[1]*ICAR RC for NEH Region, Medziphema, Nagaland*
[2]*KVK Tuensang, Nagaland*
Email: harendraicar@gmail.com

Fast degradation of natural resources is one of the main and global issues for sustaining soil health and food security in hill ecosystems. In North Eastern hill region, shifting cultivation (locally known as jhum) is the traditional way of farming, which is ecologically unsustainable due to loss of top fertile soil, biodiversity and other useful flora and fauna. This practice could not be eliminated as it is highly imbibed with their culture. During the course of such farming practices, farmers knowingly or unknowingly, have been evolving and practicing a number of self sustaining farming practices for conserving the resources, besides meeting the food and nutritional security. One such farming practice is intercropping of French bean (*Phaseolus vulgaries* L.) with maize in jhum fields. Maize is an exhaustive and high nutrient demanding crop, therefore over a period of time farmers of Nagaland evolved and practicing maize-French bean intercropping system to maintain soil fertility level in jhum fields. French bean, being a leguminous crop has tap root system, reduces soil erosion, and improves soil structure, porosity, organic matter content and water retention capacity of soil. Cultivation of French bean maintains the soil fertility by fixing atmospheric nitrogen and also helps in phosphorus mobilization. In this cultivation system fibrous shallow root system of maize and deep tap roots of French bean utilizes the nutrients uniformly at different soil depths and thus maintains the soil fertility. Further, the system also reduces the incidence of diseases and weeds.

Fig. 1 Mature pods of French bean in *jhum* field of Tuensang

French bean is a major pulse crop of Nagaland and it is grown on an area of 15,040 ha which is 40% of the total pulse area in the state. French bean commonly known as Kidney Bean, Common Bean and Rajmah and locally known as '*Kholar*' '*Khobok*' and *'Kütishe'* in Kiphire, Tuensang and Phek districts respectively. Among these local names '*Kholar*' is most popular throughout the state. There is huge diversity of this crop in the state, with high variability in colour, shape and size of the seeds as well as variation in growing season, duration, plant type and biomass production. French bean, a multi utility crop contributes to preferred diversified diet and significantly to the nutritional security of the people. Tender pods (55- 65 days of sowing) are also used as vegetables and plant biomass is a good source of fodder for the livestock. It is a potential source of proteins, carbohydrates and minerals. It contains about

Fig. 2 Dried maize stem as a staking material for French bean

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17.5 - 28.7% protein in dry seeds (1.0 - 2.5% protein in green pods), 61.4% carbohydrates, 3.2 - 5.0% minerals, 4.2 - 6.3% crude fiber and 1.2 - 2.0% crude fat.

French beans of Nagaland are known for their unique taste, softness and uniform boiling. It fetches the highest price among the pulses and thus is economically a remunerative crop in Nagaland. Among traditional landraces of French beans yellowish colored pods is mostly preferred for its taste and accrues highest price in the market. This crop is cultivated as *kharif* (August-December) and *zaid* (March to June) crop in jhum fields located in cooler areas of Khiphire and Tuensang and as a *rabi* (November- February) crop in warmer areas, *viz*., Dimapur and Peren districts of Nagaland. In Khiphire and Tuensang districts maize- French bean intercrop cultivated in zaid season followed by sole French bean as *kharif* crop. French bean is harvested in the month of May-June and used as a vegetable, and maize cobs are harvested in the month of July-August. After harvest of cobs, dried maize stems are maintained in field to be used as staking material (**Fig. 1** & **2**) for *kharif* season French bean. Maize is also a multipurpose crop used not only as food but also as feed for the livestock.

French bean is sown early in high altitude area as compared to low lying areas, because low temperature reduces the germination percentage and crop stand. Therefore, in high altitude areas, french bean is sown from July to mid-August to get good crop growth stand in fields, whereas in low altitude areas, it is sown from mid-August to mid-September. Crop planted in the month of July-August is mainly used as dried seed, whereas, *zaid* season crop is mainly grown for green tender pods. Intercropping of French bean with maize results not only in improvement of soil health condition, but also provides nutritional security and enhanced farm income. Indeed, this is a wonderful intercropping system which can be replicated in other districts of Nagaland for improving farm income.

In view of higher monetary advantage, huge domestic market demand, ecological sustenance and relatively free from pests incidence, there is need to replicate the systems in other ecologically fragile ecosystems of the state.

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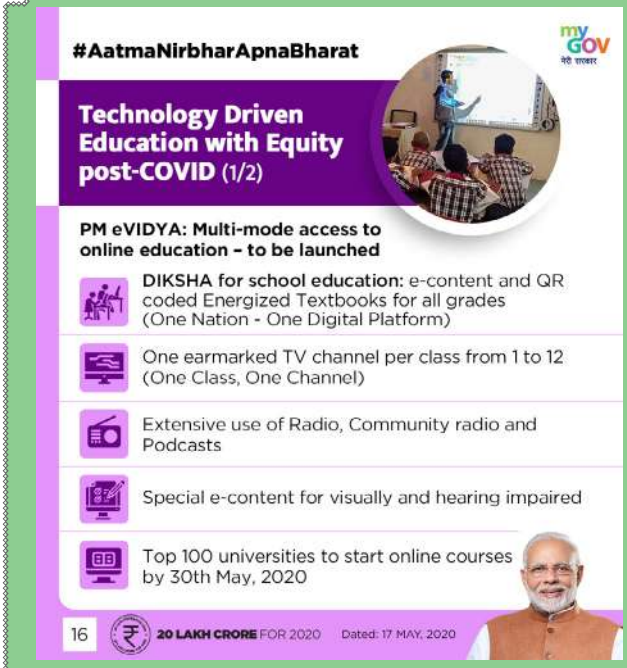

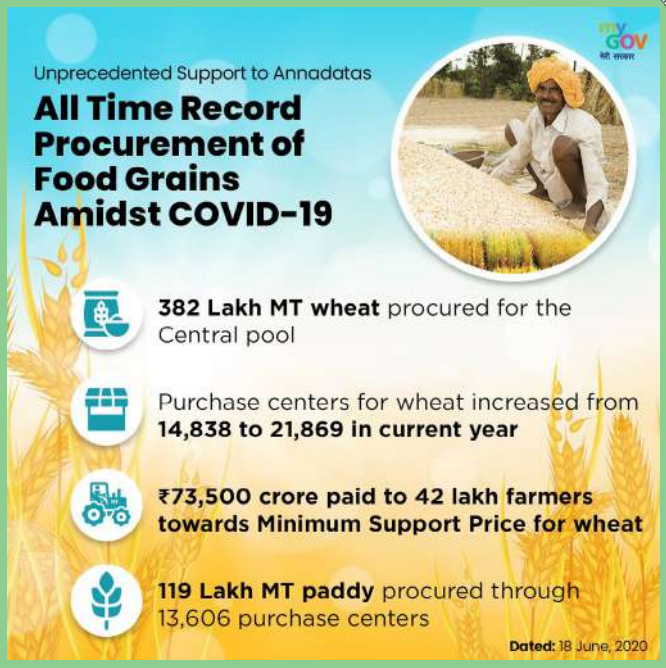

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WATER MIMOSA - AN UNDERUTILIZED AQUATIC VEGETABLE

Yengkokpam Ranjana Devi
Central Agricultural University, Lamphelpat, Imphal - 795004, Manipur
Email: y_ranjana@yahoo.co.in

Neptunia oleracea Lour. locally known in Manipur as *Eshing Ekaithabi* and commonly known as *Water Sensitive Plant* or *Water Mimosa*, is a wild floating aquatic legume native to several continents of the humid tropics of both hemispheres, particularly in Asia, Africa and South America. It is cultivated as vegetable throughout Southeast Asia, particularly in Indo-China region and Thailand.

Habitat

Neptunia oleracea Lour. grows on the banks or margins of water bodies and then spreads out over the water surface. It prefers lakes, farm dams, ponds and swamps but also grows along slow moving water ways. The north eastern region of India provides favourable condition for growth and propagation of the plant owing to its ample rainfall, humidity and moderate range of temperature. *Eshing Ekai Thabi* is found cultivated in the ponds and wetlands in valley areas of Imphal, Manipur. It is sold in the markets during its season (June-August) in bundles of 4-5 plants of about 10-15 inches length and costs around 20-30 rupees each.

Morphology

The stems are terete, rarely branched and detached from the primary root system. It forms white spongy fibrous swollen internodes and produce clustered brown fibrous adventitious roots at the nodes when growing in water. The white spongy tissue helps the plant to float in the water. The leaves are bi-pinnate with 2-4 pairs of pinnae with hairless leaflets. The leaves are sensitive to touch and fluctuations in light. Flowers are bright yellow in colour and have very long peduncles in sub spherical axillary heads. The pods are shortly oblong in umbel like cluster, green in colour. It has an unusual smell that can be used in the identification of the plant. It can be grown *via* seeds or can be propagated through cuttings. The plant is found abundantly during the rainy season. When the water level falls during the dry season, the plants often perish.

Nutritional Properties

Water Mimosa has been consumed by people from Malaysia, Thailand and Cambodia due to its nutritional values. *Meitei*, the valley inhabitants of the state of Manipur have the tradition of eating the raw plants of water mimosa, the knowledge of which is handed over from generation to generation through the belief that they get direct nutritional and medicinal benefit by this mode of eating. The edible portion of the shoot is found to contain (per 100 g): moisture- 89.4%; protein- 6.4 g; fat- 0.4 g; carbohydrate- 0.8 g; fibre- 1.8 g; ash- 1.2 g; Ca- 887 mg; P-7 mg; Fe- 5.3 mg; Vitamin A-5155 IU; vitamin B_1- 0.12 mg; vitamin B_2- 0.14 mg, niacin- 8.2 mg; vitamin C- 1.8 mg and the energy value of the plant is 184 kJ 100 g^{-1}. Several authors have reported the presence of Na, K, Ca, Mg, K, Mn, Cu, Zn, Fe, P, Pd and Ni in varying concentrations. A recent study also found that *Neptunia oleracea* has high *in-vitro* total antioxidant capacity (TAC) and the content was found to highest in stems (IC50 μg ml^{-1}: 428 ± 5.79) and leaves (IC50 μg ml^{-1}: 403 ± 2.25).

Medicinal Properties

There are different modes of use of *Water Mimosa*. It is eaten as a vegetable or used for its medicinal properties. The young leaves, shoot tips, ends of stem and young pods are usually eaten raw or in stir-fries. For medicinal benefits, the plant is either consumed fresh or as decoction or for local application and is mainly used for treatment of:

1. Nose bleeding: The pounded leaves and stem of the plant is applied over the nose to treat syphilitic ulcers/necrosis of the nose and hard palate.
2. Dysentery and intestinal infection: The leaf of the plant is eaten raw to treat dysentery and intestinal infection. Alternatively, decoction is prepared by crushing the leaves of the plant with water and given to the person twice a day (morning and evening) until cured.
3. Anthelminthic: Decoction is prepared by crushing the leaves of the plant with water and given to the person twice a day (morning and evening) for three days to treat parasitic worm infections. The decoction is used for treatment of yellow fever and Guinea worm infection in Nigeria.

4. Fever: The plant is also used for treatment of fever by applying the infusion of the whole plant on the body of the patient.
5. Earache: The juice of the stem and leaf is squeezed into the ear to cure earache

Fig. 1 *Neptunia oleracea* Lour (Water Mimosa)

Fig. 2 Cultivation of *Neptunia oleracea* Lour. in Imphal East District, Manipur

Fig. 3 Women vendors selling *Water Mimosa* in Imphal Market

6. Reports on use of *Neptunia oleracea* for treatment of sores on tongue, white discharge and epilepsy has also been documented.

Other Uses

1. *As a green manure:* The mimosoid legume genus *Neptunia* has attracted much interest in the last 15 years, largely because of the aquatic habit of some of its species and the ability of some of these to form N_2 fixing root nodules on submerged roots. The use of nodulated wetlands legumes as green manures in the cultivation of lowland rice due to their high ratio of N_2 fixation under flooded conditions has been reported so it is cultivated in Asian countries for green manures for rice cultivation.
2. *Phytoremediation: Neptunia oleracea* has been extensively used as water treatment agent in Asian countries like Thailand, Vietnam, Philippines, Indonesia and Malaysia. The most common contaminant which can be treated by *Water Mimosa* is heavy metals such as Cd, Cu, Zn and Mn. The plant is being used as phytoremediation to treat waste and polluted water. It has been established that this phytoremediation method is the most environment friendly method to treat water in addition to it being a low cost technology.

Disadvantages

However, certain disadvantages are also associated with the plant as this nitrogen-fixing legume releases nitrogen into water bodies leading to increased algal blooms and encourage growth of other weeds such as water hyacinth, water lettuce and salvinia. Excess nitrogen affects water quality and increases water-treatment costs, hence, it is declared as a restricted invasive plant under the *Biosecurity Act 2014* in the State of Queensland, Australia. If *Water Mimosa* is used for phytoremediation as pollutant cleanup method and remedy, the plant might be unsafe for human consumption and may pose health risk.

Conclusion

Based on the documented multipurpose use of the plant, it can be concluded that *Water Mimosa / Eshing EkaiThabi* is an underutilized aquatic vegetable which is embedded with rich nutrient potentials along with ability to stand against adverse climatic conditions. Due to its high nutritional and medicinal properties, the plant plays an important role against malnutrition in the weaker section of the society. Due to favourable climatic condition for growth, the large areas of unused wetland in North East of India may be cultivated with the plant which in turn will help generate sustainable income. The possible reasons for the low utilization of the vegetable in spite of their recognized importance may be the lack of information about their performance, hence, an awareness needs to be created so that the cultivation of the plant may prove to be a boon to all concerned *i.e.,* the growers, consumers and environmentalists, provided that they are tamed properly.

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10

SOCIAL JUSTICE IN PERSONAL DEVELOPMENT

Dipak Nath
Directorate of Extension Education, CAU, (Imphal), Lamphelpat, Manipur
Email: spd020@yahoo.co.in

There are things essentially for human survival and things required for human development. For any human being to have social justice, all the things under these two types of requirements should be fulfilled. Social action groups and activists in all the developing countries, especially India, are engaged in activities related to establishment of fundamental human rights, social justice and total human development. On these aspects of human life, many people have been writing, speaking and working for several centuries and yet social injustices seem to exist unabated. However, it should be noted here that, among the items of survival, the formal education and the vocational education are also basic factors for human development.

The factors that contribute to the human development are:

1. Family- Every human being is born in a family and grows and develop in a family environment. As a child, he needs a lot of care and attention from the parents. In the early days of childhood, the love and care of the mother is most essential to the growth and development of the child. And as he grows up, he looks up to the father for the models of leadership and enterprising qualities. Both the father and the mother are equally responsible for the welfare of the child. However, it is the mother who nurtures the emotional and human qualities more in a child. Her major responsibilities are to nourish and cherish the children and the family members. The father is the head of the family. He provides the family, first of all, security both physical and psychological. Second, he has to provide for the economic well being of the family. Third, he should cherish the leadership and enterprising qualities in the children. He should be strong but gentle and caring. He may be the centre of authority but he should never use his authority in an arrogant, autocratic and authoritarian way.

2. Friends- When a child is old enough to mix with others in the neighbourhood and in the school, his circle of contact widens and a number of people come into his life as friends. He interacts with them, learns his lessons in life. The importance of friends and friendships in the life of any human being for his human development is undisputable. However, there are good as well as bad friends and there are good as well as bad friendships.

3. Freedom- Freedom is a fundamental right and a primary requirement for a person to experience social justice. However, freedom is also misunderstood by many people and interpreted as freedom to do anything and everything, even at the cost of others. Therefore, there comes the question of responsible use of freedom, without which we cannot establish social justice among a group of people.

4. Formation- Formation is a very wide term which implies intellectual, psychological, mental, personal, social and cultural meanings. Formation is also related to the way human beings behave in the society. It is important, in a group of people for everyone to have the opportunity to get the proper intellectual, psychological, mental, personal, social and cultural formation. Otherwise, there cannot be social justice.

5. Fellowship- Fellowship means deeper personal relationships with someone among the friends or outside the usual friends. It is the need of any human being to have somebody to share his inner feelings and desires; he needs somebody to be open and reveal his self. Marriage can be a form of fellowship. Deep intimate friendships are also forms of fellowship. For the full flowering of the personality of a human being, fellowships are necessary and a less developed person will be at a loss in his relation to the one who is more developed in personality and hence he will not get social justice to the full extent.

6. Fitness and healthy living- The term fitness refers to the physical and mental health of the person which is very essential for a person to work in a society and to lead a decent human life. A sick man cannot feel the fullness of life and he will always be handicapped and become a victim of exploitation easily. Fitness is not merely avoiding sickness but implies more of a healthy living and all that are necessary for a healthy living which implies regularity in work, sleep, exercise, recreation, reading and learning, personal cleanliness, proper balanced diet and moderation in drinking and eating etc.

7. Fixture- Fixture refers to a decent occupation which is adequately remunerative. Self satisfying work or occupation is essential for human fulfilment because man expresses himself in his work. An unemployed man will not only find difficulty in making a living but he will also

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be bored to death if he has no occupation even if he does not need it for his lively hood.

8. Fun and recreation- It refers to relaxation of both mental and physical being. Man needs recreation to regenerate his strength, both physically and mentally, and every man has a right to proper recreational facilities. Fun and recreation is well taken care of by the social activities therefore, for the present there seems to be no need for additional facilities compared to scarcity of other requirements.

9. Facilities- It is a common term signifying a lot of infrastructural and material things which are essential for human development. The most important facilities are: road, electricity, transport, communication, schools, health centres and hospitals, banking, water supply, drainage, sanitation, recreation, consumer store, marketing, storage, processing vocational, library, community hall etc. In the modem world each one of these facilities is required for proper human development. Those who have these facilities will have an upper hand over those who do not.

10. Fulfilment- Personal satisfaction in whatever one is doing or achieving has a great impact on the development of a person. A sense of fulfilment makes a man happy and content. He is able to accept himself and he will have a feeling of inner resourcefulness. A man with the opposite feeling will be at a loss in comparison with one who has a sense of fulfilment.

11. Factual- Factual refers to the quality of being objective or going by facts and figures. That means he is scientific and rational rather than emotional. He tends to decide things based on the facts and figures. Such a person will be humanly more developed and successful than a man who is irrational and emotional in his thinking and behaviour.

12. Fastness- This is a world of competition and performance. Professionalism marks in everything one does. There are many things one is called upon to do within a day or within the working period. Man needs to learn to think faster and do things faster. One who is slower in doing things will be left behind the others and he may become an easy victim of exploitation. In order to avoid this situation, every man has to be fast at least at a reasonable level.

13. Foresight- Foresight is a characteristic which makes a man foresee and plan things ahead and anticipate them so that he is prepared when they actually occur. One who is able to foresee things, is able succeed in life compared to the one who is unable to foresee things.

14. Forwardness- Forwardness refers to progressive thinking as opposed to conservative thinking. People who think in a conservative way are always left out while others march ahead. Human development requires progressive thinking, new ideas, and new ways of doing things for human development and ultimately for social justice.

15. Follow up- The habit of follow up is essential for a man to climb the ladder of success. We often come across people who start doing things but soon they forget about it or start doing something else and then again forget about it. A man with a habit of follow up will certainly have an upper hand over a man who does not.

16. Fineness- It is a quality that makes a man strict with himself and strong in his well considered decision; will to carry out his decisions, etc. It also refers to a disciplined and systematic life and behaviour. It also is opposed to a personal trait which is characterized by wavering mentality, indecisiveness, procrastination etc. A firm and disciplined person will be able to have an upper hand over a man who is very loose in his way of doing things.

17. Faith- It means not the religious faith but confidence in oneself. To forge ahead in life one requires tremendous amount of confidence and courage within himself. Self confidence makes a man face all the problems courageously. The faith and self confidence in oneself is a factor that contributes to the establishment of social justice.

18. Fame or recognition- Every human being craves for recognition and certain amount of recognition of his achievements and works is necessary for his proper growth and development as a person. Therefore it is part of the social justice to give every human being his due recognition for what he is and what he does. At the same time he should also learn how to take recognition in a mature way when it is given to him.

19. Faithfulness- By faithfulness what is meant is the personal quality by which a man is true to his promises, reliable in his work, demandable in his dealing with others etc. It is our experience that a reliable and faithful person will succeed in life compared to a person who is not faithful or dependable.

20. Feed back- Everyone does a number of things in life thinking what he is doing is correct and the way he is doing correct. But it is only others, who observe with an impartial view, who can say what one is doing is correct or not. Therefore, for everything we do it is very important to get a feed back or evaluation so that one knows what others think of him or how others perceive the things he is doing.

21. Forgiveness- The term forgiveness is referring to the ability of a person to forgive the wrongs that somebody else has done to him. In a human society hurting someone else is something we cannot avoid as just stepping on the toe of someone in a crowd is unavoidable. It is also our experience that some people get annoyed for every small and big wrong done to them and they lose the peace of mind as well as spoil the peace of others. Therefore, one should learn to forgive others for their wrongs.

22. Forgetfulness- Forgetting something is a curse

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as well as a blessing. The necessary things we must not forget but unnecessary and painful things we must forget. If one keeps on remembering all the painful experiences he will become psychologically a broken person. One will develop into a full human being only if he is able to forget his past painful things.

23. Friction- It is something similar to what we mean in physics. A vehicle is moving ahead because of the friction its wheels are experiencing against the road. If there is no friction the vehicle will not move. Any forward movement involves or implies friction. So, in the sphere of personal development as well there should be sufficient and proper challenges for anyone to grow personally.

24. Analytical- Critical analysis of every experience and everything one comes across is a prerequisite for anyone to develop his personality. Analyzing ideas, views and action programmes will make him learn from his own mistake and he will develop in a better way compared to one who is not in the habit of analysing critically.

25. Enterprising- Entrepreneurship is that characteristic which makes a person face risks in starting something new. It is a combination of courage, planned risk taking, and intelligent management of one's resources. Some people have more of this talent while others have less. However, it is possible to develop a reasonable amount of entrepreneurship in every one.

26. Saving- Capital is required for everyone and capital formation does not take place unless one conscientiously does the saving. Often people say that there is no saving after all the expenses. "Saving is total income minus expenses." One who has saving also will feel psychologically stronger compared to the one who does not have any saving.

27. Receiving and giving- Man is a social animal and for his existence he has to be continuously receiving and giving. Receiving is as important as giving. Everything a man has is what he has received from other people. It is our common experience that people are very reluctant to receive something from others even if they are ready to give.

28. Planning and calculative- Planning is very important for the success of any human activity. Time is the most precious thing in the world and in order to make the maximum use out of this most precious resource one has to plan his work. Among the animals, only human beings are able to plan their work.

29. Inquisitiveness- Inquisitive man goes about always looking for new knowledge and new ways of doing things and every day he will be acquiring new ideas and technologies which will make him more efficient and effective.

30. Systematic- Order, arrangement, proper ways of doing things, proper places to store things, classification of materials, methodical, organized etc. are meant by systematic. Development signifies progress and progress in any thing is not possible unless one is doing things systematically, whether it is acquisition of knowledge or doing something technical. No doubt a systematic man will have an upper hand in life situation over a man who is disorderly and unsystematic.

31. Knowledge or science- For a man, knowledge is power and the more his knowledge greater will be his power. From the practical point of view the knowledge can be classified into general knowledge and specialized knowledge. Both types of knowledge are important for a person for his overall development. One should acquire knowledge on wide range of subjects.

32. Technology- Technology means the knowledge of what to do and how to do. Knowledge is theoretical, ideological, in the mind, in the imagination and is conceptual.

33. Tools and instruments- Man is a tool using animal and depending on the expertise he gained in using the tools and instruments his work and production efficiency increases. Tools and instruments are extension of his five senses, his hands and brain. Through the microscope he can see what he cannot see through his naked eyes, through the television he can see things happening in a place thousands of kilometres away. Similarly, he can hear and feel things which he cannot normally hear and feel.

Conclusion

There may be other qualities too that could be added to the list mentioned above. However, according to many people I consulted these are the most important factors that contribute to the human and personal development of any man. If anyone is lacking in anyone of these factors he will become an easy prey to those who have acquired more of these. It is certainly not possible for everyone to have all these qualities at a very high degree. But everyone can acquire all these up to a reasonable level so that he is not exploited or marginalized in the society. Social Justice is a personal and overall opportunity that will ensure for everyone all the things required for a decent human survival, growth and development. If anyone is missing social justice it becomes a mere wishful thinking for a person.

Further Readings

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CAU- REGIONAL AGRICULTURE FAIR 2019-20 A BRIEF REPORT

M. Premjit Singh[1], R. K. Saha[1], B. N. Hazarika[2], N. D. Bhutia[2], D. K. Pandey[2], Chandra Deo[2], P. Sarma[2] and Dipak Nath[1]

[1]Central Agricultural University, Imphal, Manipur
[2]College of Horticulture and Forestry (CAU, Imphal), Pasighat - 7911102
Email: bnhazarika13@yahoo.co.in

CAU Regional Agri Fair, 2019-20 was held at CHF, Pasighat (Arunachal Pradesh) with the theme "**Ecosystem Approach for Sustainable Agriculture**" during November 11-13, 2019 with the financial support of Ministry of Agriculture and Farmers' Welfare, GOI, New Delhi. The programme was inaugurated by Hon'ble Speaker of Legislative Assembly of Arunachal Pradesh Shri Pasang Dorjee Sona in presence of Guests of Honour, Shri D. Wangchu, Hon'ble MLA, Kanubari, Arunachal Pradesh; Prof. V. Damodar Naidu, Vice-Chancellor, ANGRAU, Andhra Pradesh; Prof. Saket Kushwaha, Vice-Chancellor, Rajiv Gandhi University, Arunachal Pradesh; Prof. H. S. Yadav, Director, NERIST, Arunachal Pradesh; Dr. Kandapal, Director, ICAR Research Complex for NEH Region, Umiam, Meghalaya and Mr. T. Borang, Addl. DC, East Siang, Arunachal Pradesh. Prof. M. Premjit Singh, Vice-Chancellor, CAU, Imphal presided over the inaugural ceremony. Prof. R. K. Saha, DEE & Organizing Secretary, CAU, Imphal presented the welcome address and vote of thanks was proposed by Prof. B. N. Hazarika, Dean, and Local Organizing Secy. During the inaugural programme, different publications *viz.*, Souvenir of CAU-Regional Agri-Fair 2019-20, CAU Calendar 2020, Kisan Diary 2020, CAU Newsletter; CAU Farm Magazine, Book on Farmer as Innovator: Farm Innovations of Seven Sisters and One Brother, etc. were released. While addressing the farmers and delegates, the Hon'ble Speaker Shri Pasang D. Sona said that most of the Agricultural products in the State are organic. He expressed confidence that the CAU-Regional Agri Fair, 2019-20 would help to persuade the farmers of Arunachal Pradesh and the other NEH States to adopt modern agricultural technologies, especially in organic farming to enhance their farm productivity and boost the rural economy.

The inaugural programme was attended by more than 800 farmers/growers and representatives from Line Depts., ATMAs, KVKs, NGOs, SHGs, and Farmers' Club across the North Eastern States.

Exhibits were displayed in 51 stalls by 51 participating organizations. The organizations including the constituent colleges of CAU, Central Institutes, State Line Departments, ICAR, Cooperative Societies, and Innovative farmers/growers participated in the fair. During the three days programme, 1220 farmers from all districts of Arunachal Pradesh and the other NEH states registered for participation in "Farmers-Scientists Interaction" Programme, Different shows, and competition on flowers, fruits, vegetables, dog and healthy baby (1-3 years of age). Nearly, 1274 visitors from different walks of life, school children, and representatives of private companies visited the fair.

Exhibition of Agricultural Technologies

The exhibition of improved agricultural technologies and equipment including showcasing of agro-industrial

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products and processes were displayed throughout the Agri-Fair for the benefit of the farmers/visitors, entrepreneurs, and other stakeholders. Among the constituent colleges of CAU, the technologies/ products showcased there included scented black rice of Manipur by the COA, Manipur; processed and packed fish products by the COF, Tripura; garments, handicrafts and RTS food products by the CCSc, Meghalaya and so on. Budded plants of *Khasi* mandarin, the specimen of cherry tomato, improved varieties of vegetable seeds and RTS based on aloe vera by the CHF, Pasighat, Arunachal Pradesh. The CPGS-AS, Meghalaya depicted the findings on improved crop production systems, water management, soil conservation, and varietal improvement of organic crop protection. The CAE&PHT, Sikkim displayed the improved types of equipment and technologies on production and processing of agricultural produce as well as different farm operations including improved water management, protected cultivation in poly houses and gadgets of renewal energy; smokeless stove, solar dryer, etc., and also demonstrated the shrink packaging of orchids and many RTS from ginger, sea buckthorn, and mandarin products. The improved varieties of orchids and different value-added products were also displayed by the innovative farmers/growers and were sold to the interested consumers at the end. Besides, many agro-horticultural tools and equipment were displayed and put for sale to the interested buyers.

Technical Session and Farmers-Scientist Interaction

Objectives

1. To know the actual problems of farmers in relation to sustainable farming system and discuss remedies for high production & propagation of field crops
2. To discuss standardized methodologies for Plant Protection measures of field crops
3. To discuss postharvest management and utilization of practical application in economically important field crops

Sub-themes

Session I	:	Sustainable Agriculture Production
Session II	:	Sustainable Horticulture Production
Session III	:	Sustainable Livestock Production
Session IV	:	Sustainable Crop protection measures
Session V	:	Value Addition, Post-Harvest management & marketing of agricultural produce

The inaugural session was followed by 3 combine technical sessions, dated November 11, 2019 the details of the sessions are as follows:

A. Technical Session I, II & III: Sustainable Agriculture Production; Sustainable Horticulture Production; Sustainable Livestock Production

The welcome and introductory remarks were given by Dr. K. K. Jindal, Former DR, Dr. YSPUH&F-Solan and CAU-Imphal; Prof. Edwin Luikham and Dr. Y. J. Lego, DDA, Pasighat. During the interaction Dr. K. K Jindal, shared the information on the status and background of the study conducted in the year 2000 for *Kiwi* Plantation. He also spoke about the difficulties he faced during the establishment of the first farm of *Kiwi* Plantation in a 5-acre area later in was expanded to 50, 000 ha.

Prof. M. Premjit Singh concurred with the observation that farmers group/ club facing the problem of less income while using available measures in agriculture and horticulture crops. They should go for a scientific approach from organizations like CAU where they can get training and suggestions to start their work more appropriately.

Dr. H. Prasad from Mizoram made a presentation on the importance of organic farming in livestock management and animal husbandry. Being associated with pig farming for more than 10 years he observed the basic problem of deficient knowledge of management being faced by farmers of Northeastern states. He highlighted the chief role of feed that plays an important role in successful pig production.

The first session, chaired by all the Deans of CAU, Dr. Jindal, Former Director of Research, Dr. YSPUH&F, Solan and CAU, Imphal and Prof. Edwin Luikham and Dr. Y. J. Lego, DDA.

B. Technical Session IV: Sustainable Crop Protection measures

The technical session IV was chaired by all Deans,

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CAU, Imphal and Co-chaired by Dr. D. B. Ahuja, Dr. P. Raja and Dr. R. C. Shakywar, CHF, CAU, Pasighat. The session had two presentations, in the first presentation Prof. K. Momocha Singh, CAU, Imphal gave a vision on pest management in crops with special emphasis on insect pest management techniques. The presentation sought to address the issue of insect pest management of crops by natural enemies. He stated that AESA (Agro Eco-system Analysis) will enhance improvement of crop protection in Organic Farming in the near future. He explained the methodology of AESA, and proposed to transfer the information technology like "Insect Zoo concept" to the respective farmers.

Prof. M. Premjit Singh, Hon'ble VC, CAU, Imphal also discussed the current situation associated with the serious disease of soft rot of ginger crop that demonstrates how crucial it is for farmers to get back invested money from the crops like ginger.

Technical Session V: Value addition, Post-Harvest Management, and marketing of agricultural produce

Dr. Ng. Piloo shared her experience where she tried to cover maximum topic related to post harvest, processing and value addition of crops. She emphasized on primary and secondary post-harvest management

of spices crops. She elaborated the various post-harvest and processing techniques such as washing, killing, drying, boiling, packaging and storage. In addition to reducing the labour, mechanization helps in maintaining the quality and food safety standards, she added. Improvements in hygiene, packing and storage facilities will not only help in keeping quality of spice flavours but also plays a major role in reducing aflatoxin and salmonella contamination of crops and spice products.

Afternoon Session of the 2nd day, it was discussed mainly based on better understanding of the frame work of Entrepreneurship. Resource person concluded that a farmer does not become an entrepreneur only by adopting new agricultural technology but he becomes an entrepreneur only when he comes to be an operator of farm business.

Some Queries and their Answers/Clarifications

During all the technical sessions following important farmers' queries were discussed by the experts:

Q.1 *Ms. Tumba Paking, Nari Village, East Siang District, Arunachal Pradesh:* The farmer has been cultivating oranges for many years; she is facing problem related to insect infestation in her farm as well as reduction of productivity since 2014 to 2019. She explained that the peak infestation period of pest is during June to July.

Ans: She was suggested to use fungicides like chlorpyriphos and rodomel in her field. It was also mentioned that due to acidic condition of the soil especially in Pasighat region, it is preferred to use 2, 4- D plant growth regulators. 2, 4- D is used mainly to delay and reduce unwanted fruit abscission (fruit drop). Use of bio-pesticides to check the growth of pest in such crops was also suggested.

Q.2 *Miss Yasann Nonang, Bilat village, East Siang District, Arunachal Pradesh:* She asked about remedial measures for balk smut disease in rice.

Ans: It was suggested by the expert that Neem based fungicides has significant antifungal activity and is very successful against fungi that cause certain plant diseases *viz.,* rots, smuts, wilts, mildews, diebacks and other plant diseases.

The panel of experts also opined that Neem products are very useful against diseases of field crops, vegetable crops and fruit trees. The treatment required use of 5 ml Neem based product mix in one-liter water and spray in crops at an interval of 15 days.

Q.3 *Mrs Mum Padung, Rayang village, East Siang District, Arunachal Pradesh:* She asked about the disease related to mineral deficiency in pigs.

Ans: The experts suggested following routine vaccination program. Protection against *lepto, parvovirus* and erysipelas should be given either at pre-farrowing or at weaning, depending on the best timing for that particular herd.

Once or twice a year, vaccinating for influenza can boost herd protection. If influenza has been a problem in piglets historically, consider vaccinating sows pre-farrowing. The recommendation for round worm and tape worm infection was suggested by experts *viz.*, Panacur – 500 mg tablet twice a day, one tablet orally empty stomach repeats another tablet after 21 days.

Q.4 *Mrs. Oman Padung, Ledum village, East Siang District, Arunachal Pradesh:* She asks suggestion to manage Citrus Canker.

Ans: Dr. L. Wanchu, Assoc. Prof., CHF, CAU suggested three sprays of antibiotics (Streptomycin or Tetracycline) @ 600 ppm at an interval of every 3 months.

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Q.5 *Mr. Dinendo Roi, Junai, Assam:* He raised a question relating to the management of mealy bug in chilli and brinjal.

Ans: He was suggested for application of Neem formulation along with soap solution or detergent @ 1%. Further, it was opined that use of *Cryptolaemus montrouzier* are also effective to reduce the mealy bug population. They are natural enemy for mealy bugs.

Q.6 *Mrs. Asar Darang, Ranging & Mr. Yabem Mibong, Miklung, East Siang District, Arunachal Pradesh:* They raised query about banana trunk borer management.

Ans: Dr. Chandra Deo, Assoc. Prof., CHF, CAU and team suggested rotten banana plants are the main reason for spread of trunk borer in fields. They suggested for removing the banana plants just after fruit harvesting, cleaning of all the dry leaves time to time. He also suggested minimizing the number of suckers per banana plant. Maximum one small sucker should be allowed with plant.

Q.7 *Mrs. Ouk Sitang, GTC, Pasighat, East Siang District, Arunachal Pradesh:* She was seeking information on impact of integrated disease management in crops. She also asks about the control measures of Chirke and Forky disease of Large cardemun.

Ans: In response to her query Dr. P. Raja, CHF, CAU, Pasighat, highlighted the impact of integrated disease management in crops.

The speaker mentioned that susceptible host, virulent pathogen and favourable environmental factors are involved in the development of disease. He informed that climate and acidic soil condition also plays an important role in creating the disease severity and also mentioned the important disease and their management aspects under Arunachal Pradesh condition in which viral disease like Chirke and Foorkey is most severe. Seedling rot, leaf blight can be managed by application of *Trichoderma viride* @ 0.5% or Carbendazim and spraying of Mancozeb or Copper oxychloride @ 2 g l^{-1} of water. He strongly suggested to avoid growing of susceptible variety of large cardamom Ramsey.

Dr. P. Raja also talked about turmeric disease, leaf spot and leaf blotch and recommended 1% of Bordeaux mixture and 0.2% of Copper oxychloride for the management of above mentioned two diseases. In addition, he explained complex disease of ginger that is rhizome rot caused by bacteria, fungal pathogen and nematodes. He also expressed that due to lack of shade in field there is occurrence of leaf spot of ginger.

He recommended soil treatment with CAU Green gold (*Trichodermaviride*) mixed with farm yard manures @ 5 g T.V + 95 g FYM before planting and also stressed the necessity of proper storage of ginger.

Further it was suggested to eliminate the infected plants from the field, application of Dimethoate and to follow crop rotation.

Q.8 *Mrs Deng Perme, Dambuk village, Lower Dibang Valley District, Arunachal Pradesh:* She asked idea on importance of fruits crops as source of income generation. She also asked how to dry the chilli and other horticultural crops.

Ans: In reply, the panel experts highlighted the importance and potential of fruits crops as a source of business in NE regions.

They stressed that there is a tremendous opportunity in promoting potential fruits crops like oranges & there is a growing market for some other related indigenous crops like oranges and there is a growing market for some other related indigenous crops. In entire discussion, it was concluded that there is a tremendous opportunity in promoting these highly demanding fruit crops and there is a growing market for them. Fruit crops having high demand, limited distribution, high value, low inputs and less volume should only be brought under cultivation for the monetary benefits of the farmers.

Dr. Ng. Piloo, Assoc. Prof., CHF, CAU and panel members suggested different techniques to reduce the time for drying the above item through Tunnel dryer, low cost polyhouse dryer and also vacuum packing of green chilli.

Q.10 *Mr. Tason Jamoh & Mrs. Odam Darang, Miglung Villege, East Siang District, Arunachal Pradesh:* They asked about insect in tree trunk of orange (Trunk / stem borer in citrus).

Ans: Dr. L. Wangchu, Assoc. Prof., CHF, CAU and team suggested to locate the infection followed by cleaning of hole made by the pest, plugging the hole with cotton swab dipped in insecticide/kerosene/ petrol and sealing the hole with clay. To locate the adult by shaking trees in the month of April-June and control manually.

Q.11 *Mrs Yatung Padung, Ledum & Sri Mity Mayong, Sibo village, East Siang District, Arunachal Pradesh:* How to manage citrus trunk borer in citrus orchards?

Ans: It was elaborated that best time to manage the pest is when adult beetle which is grayish in colour with black spots starts emerging. Paste the tree trunks with lime paste (2 kg lime/10 lit water and 50 ml Dimethoate up to one-and-a-half-meter height and tie rice husk around the tree trunk to prevent egg laying. Catch the beetles and kill manually.

Q.12 *Mrs Oyang Taring, Billat, Mr. Oyuk Sitang, Rune, Mr. Meetal Rome, Ngopok, East Siang District, Arunachal Pradesh:* How to prevent the damage of leaf minor and white fly and other sucking insect pests in citrus saplings.

Ans: Dr. D B Ahuja, Prof., CHF, CAU, Pasighat suggested to spray Spinosad @ 3 ml 10 l^{-1} or Profenophos 50 EC @ 1 ml l^{-1} of water to prevent the damage due to leaf minor, white fly aphids and other sap sucking insect pests. The recommendation is effective to other crops also.

Q.13 *Mrs. Negri Tabi, East Siang District, Arunachal Pradesh:* She asked about the problems of fruit drop in orange (pre-harvest fruit drops in Khasi Mandarin).

Ans: Dr. L. Wangchu, Assoc. Prof., CHF, CAU recommended to Spray NAA @ 15-20 ppm during August and September to control fruit drops.

Dr. Chandra Deo, Assoc. Prof., CHF, CAU recommended to spray insecticide during berry (small fruit) formation since adult insect lay eggs on the berry fruit collar region and later egg hatches. This insect is also a reason for fruit drop.

Q.14 *Mrs. Nanung Megu , Mebo and members from SHG- Leisi Lemo Lic Ruksin and SHG- Sanggo Ane Namsing, East Siang District, Arunachal Pradesh:* They seek information regarding value added products of Khasi Mandarin and Pine Apple.

Ans: Dr. Pushpendra, Asstt Prof., CHF, CAU and Dr. Dicko Singh, Asstt Prof., CHF, CAU suggested to prepare such as pineapple chunks, slices, juices, syrups, jams, crushed pineapple, diced pineapple etc. They also informed that the wastes from processing of fruit are now further processed into sugar, wines, vinegar, animal feed etc.

Q.15 *Ms. Oti Tayang, Mebo village, East Siang, Arunachal Pradesh:* They raise the problems about shoot borer in Ginger.

Ans: Dr. D. B. Ahuja, Prof., CHF, CAU, Pasighat addressed the query; he expressed that withering of the central shoot is the major symptom of damage due to the pest. It can be managed by spray application of Coragen 50 ml 10 l^{-1} or application of Azadirachtin 3000 ppm at 3-5 ml l^{-1} of water from July to October.

Q.16 *Mrs Nui Parom & Mrs Atung Ratan, Ngopok village, East Siang, Arunachal Pradesh:* They questioned about Management of chilli mite/ insect.

Ans: The resource persons opined that damage due to chilli mite becomes evident by darkening and curling of leaves. It can be managed by application of Azadirachtin 3000 ppm at 3-5 ml l^{-1} of water or Omite 57 EC at 1 ha^{-1}.

They also suggested use of Neem based products.

Q.17 *Ms. Yalo Saroh , Jhampani, Mr. Yagum Taga, Takilalung, Member from Misang- SHG, Namsing, East Siang, Arunachal Pradesh:* They asked for measures to be taken for getting success in rice cum fish farming system.

Ans: Dr. Bedajeet Singh, CAU, Imphal explained in detail about rice fish farming system. He also elaborated how to make trenches and shelter in paddy field for fishes.

Further, he strictly suggested not stocking grass carp in rice fish farming system.

Q.18 *Members of SHG viz., Mole Ane -SHG, Sikhabamin, Mishang -SHG, Namching, East Siang, Arunachal Pradesh:* Raised the problems about cultivation Millets and Rice.

Ans: Dr. Edvwin Luikham from CAU Imphal explained in details about millet cultivation.

He suggested the rice varieties released from CAU viz. CAU R-1, CAU R-2 and CAU R-3 is good for NE States.

Q.19 *Mr. Kahi Saroh, Ledum Village, East Siang, Arunachal Pradesh:* He enquired about feeding of fishes.

Ans: He was suggested to use nutritionally balanced floating fish feed. Further, keep it in view of unavailability of good quality feed in his locality, he was suggested for supplementary feeding of oil cake and rice bran with a mixing ratio of 1:1 @ 5% of body weight of fishes initially and 2 % of body weight of fishes in later stages.

Q.20 *Mr. Taki Muang, Mirem Village, East Siang, Arunachal Pradesh:* He enquired about best methods to be adopted for feeding of fishes.

Ans: It was opined that if a farmer is using dust feed or mustard oil cake, rice bran etc., he or she should go for bag feeding method.

Advantages of bag feeding method:

1. Proper utilization of the feed.
2. Daily feeding is not required.
3. Less wastage of feeds.
4. Better food utilization or FCR can be obtained.

Q. 21 *Mr. John Ering, Sille Village, East Siang, Arunachal Pradesh:* He asks name of the fishes and quantity should be stock.

Ans: He was suggested to do composite fish culture. Fingerlings of Rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigala (*Cirrhinus mrigala*), Grass Carp (*Ctenopharyngodon idella*), Common carp (*Cyprinus carpio*) and Silver carp (*Hypophthalmichthys molitrix*) in a ratio 2 Catla: 2 Rohu: 1.5 Mrigal: 2 Silver carp: 1 Grass carp: 1.5 Common carp at the rate of 8000 fingerlings per ha was suggested.

Q.22 *Mr. Obit Mibang, Mangnang Village, East Siang, Arunachal Pradesh:* Infected fish shows erratic swimming behaviour & reluctant to accept feed. Parasite is visible with naked eye and ulceration is seen at the attachment site.

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Ans: Problem suspected is Argulosis (Carp lice).
Suggestions given are:

- Application potash ($KMnO_4$) to the infected fish pond at the rate of 4 mg l^{-1} of water.
- Application of cleaner solution to the infected fish pond at the rate of 50 - 100 ml $bigha^{-1}$ water spread area.

Q.23 *Mr. Ape Taki, Takilalung village, East Siang, Arunachal Pradesh:* Why liming is needed in fish ponds?

Ans: It was informed to him that application of lime i s done not for fertilizing the pond but as a remedial measure necessary in acidic pond.

The advantages of liming are:

a) Neutralize acidity.
b) Increases pH of bottom soil and thereby enhancing the availability of phosphorus added in fertilizer.
c) Accelerate the microbial activity and thereby diminishing the accumulation of organic matter in pond bottoms and favouring recycling of nutrients.
d) Maintain the alkalinity and other physic-chemical characteristics of soil, which in turn helps in enhancing fish production.
e) Improving the hygiene of pond bottom.

Q.24 *Mr. R Doley, Naharbandhana, Junai, Assam:* He enquired about breeding method of common carp.

Ans: In response to the query the expert described *hapa* breeding method of common carp. He told that an appropriate selection of brood-stock is very important to obtain better results in breeding. Potential female has swollen abdomen due to developing ovaries and in the case of male, the milt ooze out when the abdomen is gently pressed towards the genital pore.

Breeding can be done in *hapa* with a dimension of 2 m x 1m x 1m. Mature male and female common carp species should be released in the breeding hapa at a ratio of 2:1. Aquatic weed water hyacinth (*Eichhornia cracipes*) should be spread in the *hapa* to collect the adhesive eggs in the roots of the weed. When the fish had spawned, the water hyacinth with the eggs attached to it should transfer to hatching *hapa*. Around 50,000 eggs should be kept in one *hapa*. Hatching took places in a period of 36-37 h depending on water temperature. The weeds should be removed carefully after hatching of eggs keeping the hatchlings in the same *hapa* for 3-4 days until the yolk sac absorbed, after which hatchlings should be shifted to nursery pond.

Shows and Competition

Following shows and competitions were organized and also awarded 3 prizes for each of the category. Altogether 51 awards were handed over to the winning farmers with certificate and cash prizes:

S. No.	Category	Crop
1	Major Fruits	Orange & Mandarin Group
2	Other Major Fruits	Banana, Pineapple, Papaya
3	Minor Fruits	Minor Citrus, Apple, Kiwi, Anola, Passion Fruits, Carambola
4	Cole And Solanaceous Crop	Cabbage, Cauliflower, Knolkhol, Tomato, Brinjal, Chilli, Potato
5	Legumes & Cucurbits/ Spices	French Bean, Cowpea, Pumpkin, Bottle Gourd, Ridge Gourd, Spomnge Gourd, Cucumber, Turmeric, Ginger, Black Pepper, Large Cardamom
6	Minor Vegetables	Leafy Vegetables, Broccoli, Colocasia, Yam, Tapioca, Mushroom
7	Flower	Potted Flower, Foliage (Fresh), Cactus & Succulents
8	Flower	Cut Flowers/ Dry Flowers/ Bonsai
9	Medicinal and Aromatic	Medicinal and Aromatic Plant
10	Major Field Crop	Rice, Wheat, Maize & Sugarcane
11	Minor Field Crop (Millets, Buck-wheat, Etc.)	Millets, Buckwheat
12	Oilseeds	Rape, Mustard, Sesame, Groundnut & Soybea
13	Processed Product (Veg)	Pickle, Chips, Candy & Ketchup, Jam / Jelly & Squash
14	Processed Product (Non-Veg)	Fish & Meat
15	Forest Products and Others	Handicrafts, Bamboo Products
16	Baby Show	Upto 1 Year
17	Baby Show	1-3 Years
18	Dog Show	Dog

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Valedictory Function

Valedictory function of CAU-Regional Agri-Fair 2019-20 was organized on November 13, 2019 under the chairmanship of Prof. M. Premjit Singh, Hon'ble Vice Chancellor, CAU, Imphal. The Chief Guest of the function was Shri Kaling Moyong, Hon'ble MLA, Pasighat, East Siang District, Arunachal Pradesh; Dr. Kinny Singh, Deputy Commissioner, East Siang District, Arunachal Pradesh, Dr. Prabhu Kumar, Former Zonal Project Director (ICAR-Zone 1 and Zone VIII); Dr. K. K. Jindal, Former Director of Research, Dr. YSPUH & F, Solan and CAU, Imphal; Prof. M. M. Adhikari, Former Vice-Chancellor , BCKV, Kalyani and Shri. Talem Mize were the Guests of Honour. The Chief Guest and the dignitaries visited the exhibition stalls along with Prof. M. Premjit Singh, Hon'ble Vice Chancellor, CAU, Prof. R. K. Saha, Director (EE), CAU, Imphal and Prof. B. N. Hazarika, Dean, CHF, Pasighat, Arunachal Pradesh. The certificates of participation in the fair were awarded to all the participating organizations. In the valedictory function, Prof. R. K. Saha, Director (EE), CAU, Imphal summarized the proceedings of the three days Agri-Fair highlighting the salient features of farmers-Scientists interaction programme, different shows and competition on flowers, fruits, vegetables, dog, healthy baby show (Category I: 0-1 years; Category II: 1-3 years of age) and innovative farmers/growers including the exhibits who showcased their technologies in different stalls for the benefit of farmers/ visitors to the Fair. The Guest of Honour, Prof. M. M. Adhikari addressed the farmers appreciating their interest in the CAU-Regional Agricultural Fair, 2019 and urged them to take advantage of research findings of CAU for incorporation in their farming practices. The Chief Guest Shri Kaling Moyong, Hon'ble MLA expressed his happiness on satisfactory organization of the CAU-Regional Agri Fair 2019-20 and appreciated the programme of "Farmers-Scientists Interaction" on various problems for appropriate solutions in participatory mode. Prof. M. Premjit Singh, Hon'ble Vice Chancellor and Chairman of the valedictory function, congratulated the farmers and scientists for satisfactorily organizing the Regional Agri-Fair. He expressed his satisfaction for participation of farmers in large numbers during all the three days coming from Arunachal Pradesh and from all the states of NEH Region under the jurisdiction of CAU-Imphal along with the students and Deans of the constituent colleges, officers of the University and all the delegates. As CAU–Regional Agri-Fair is known for the results of its "Farmers-Scientists Interaction", he emphasized that the farmers of the region should take the advantage of expertise available in the CAU to obtain higher production and profitability from agriculture, horticulture, animal science, home science, fishery and agricultural engineering and post-harvest technology by integrating the requirements as and when need arises. He appreciated the co-operation of departments of government including ATMA, KVKs, SHG_S, NGOs and Farmers Clubs in Arunachal Pradesh. He highlighted the role of media in Arunachal Pradesh including Doordarshan Kendra to give wide coverage to this annual mega event of Central Agricultural University for general awareness of farmers of Arunachal Pradesh and other States of NEH region.

The Chairman along with the Chief Guest and Guests of Honour awarded the Certificates and Cash Prizes to the winners of different shows and competitions. The vote of thanks was proposed by Prof. B. N. Hazarika, Dean, College of Horticulture and Forestry, Pasighat, Arunachal Pradesh.

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