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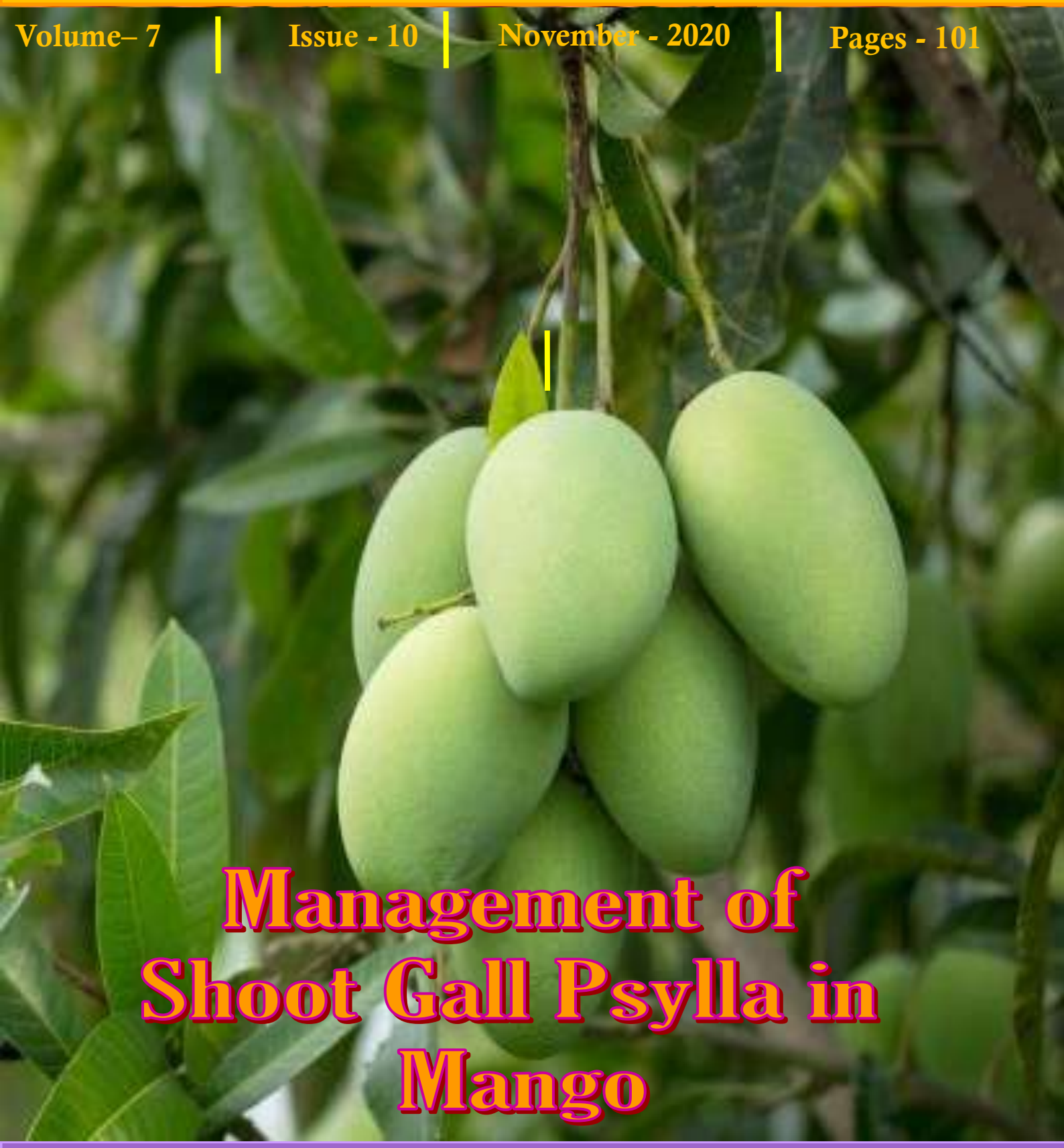

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Indigenous Technological Knowledge (ITKs) for Weed Management

Dr. Satish Kumar*, BheruLal Kumhar, Vijay Kumar

Assistant Professor, GH Raisoni University, Chhindwara, Madhya Pradesh
Ph.D. Scholar, JNKVV Jabalpur, Madhya Pradesh

**Correspondence Author: satishkumarjatav022@gmail.com*

WHAT IS INDIGENOUS KNOWLEDGE?

Indigenous knowledge (IK) generally refers to knowledge systems embedded in the cultural traditions of regional, indigenous, or local communities. IK is the knowledge that an indigenous (local) community accumulates over generations of living in a particular environment. This definition encompasses all forms of knowledge – technologies, know-how skills, practices and beliefs – that enable the community to achieve sustainable livelihoods. A number of terms are used interchangeably including indigenous knowledge (IK), Traditional Knowledge (TK), traditional ecologic knowledge (TEK), Indigenous Technical Knowledge (ITK), Local Knowledge (LK) and Indigenous Knowledge System (IKS). Traditional knowledge includes types of knowledge about traditional technologies of subsistence.

Indigenous Knowledge "Local or indigenous knowledge refers to the cumulative and complex bodies of knowledge, know how, practices and representations that are maintained and developed by local communities who have long histories of interaction with the natural environment".

CHARACTERISTICS OF ITK

• It is based on experience and local knowledge acquired from observation over time. It is therefore, often argued that it may be most useful for local scale decision making.
• It shows an understanding of the complex relationships between the individual components and the dynamic ecosystems within which they act.
• ITK often describes the symbiotic relationship and provides the basis for life sustaining decisions about how to relate to the environment.
• Sustainability, cultural survival and ITK are related through social organization, human interaction, institutional arrangements, values and moral codes of conduct.

• This is reflected in the belief of many indigenous people that they were put on the earth to care of the land, if they destroy it then themselves are destroyed.

SOURCES OF ITK

The following are the major sources of ITK.

• Farmers, community members, especially elders, are the best sources of ITK. But, since ITK is unevenly distributed in communities, it is important to find out who knows what in order to tap the right sources. Otherwise, data will not truly reflect ITK in the community. For example, asking men about garden plants when women are in charge of home gardens might lead you to conclude that villagers know little about gardening.

• Folklore, songs, poetry and theatre can reveal a great deal about people's values, history and practices. These are often not written down and need to be recorded.

• Although ITK is mostly transmitted by word of mouth, some indigenous forms or record keeping exists. These community records include writings, painting and carvings.

• People working with communities such as extensionists can be valuable sources of ITK. Other resource persons are local school headmaster, co-operative society officials, village milk operative members, and village Panchayat Sarpanch.

• Secondary sources include published and unpublished documents, databases, videos, photos, museums and exhibits.

Importance of ITK

• In the emerging global knowledge economy a country's ability to build and mobilize knowledge capital, is equally essential for sustainable development as the availability of physical and financial capital (world bank, 1991).

• The bases component of any country's knowledge system is its indigenous knowledge.

• It encompasses the skills, experiences and insights of people, applied to maintain or improve their livelihood.

• Significant contributions to global knowledge have originated from indigenous people for instance in medicine and veterinary medicine with their intimate understanding of their environments.

• Indigenous knowledge is also the social capital of the poor, their main asset to invest in the struggle for survival.

• Accordingly, indigenous knowledge is of great relevance for the development process in the following sectors: Agriculture, Animal husbandry and ethnic veterinary medicine, Use and management of natural resources

These kinds of knowledge are crucial for the subsistence and survival and are generally based on accumulations of empirical observation and interaction with the environment. Some of the ITKs in relevance to weed control as reported in the literature are summarized as below-

In weed management farmers knew of hand weeding/ picking and the use of ash to control weeds/ pests. Ash is spread/ broadcasted over field for weed control, surface soil crust breaking, and making soil more porous by conserving the rainwater.

- To save ratoon crop of sugarcane, farmers use sugarcane leaves for mulching in between the rows. After first rain in June, they apply 50 kg urea per acre as top dressing for fast rotting of the sugarcane leaves. By this process farmers save sugarcane crop from weeds and minimize the cost on inter culture operations.
- To minimize the weeds and as well as increase nitrogen level in field, farmers grow sesamum or sesbania crop.
- Farmers grow sunhemp in those fields where the motha weed is problem.
- Summer ploughing was practiced to get rid of weeds, killing soil borne insects and pathogens, to eliminate/eradicate non-crop plants in the field and to enrich soil nutrients potassium. The fact is that the soil burning was a practice to clean field in short time. About 79.17 per cent of the farmers practiced summer ploughing in the summer fallows. Farmers believed that resting stages of insects and pathogens get destroyed when exposed to sunlight, weed growth could be eliminated by deep and frequent summer ploughing and hardening of laterite soil with the result of moisture reduction, deep ploughing loosen the soil and help in soil moisture conservation.
- Summer ploughing is done for weed control & also for controlling insects-pests.
- Hand weeding is used for weed control.
- For destruction of all type weed seeds, before sowing the crop irrigation & ploughing method is used.
- Burning of weeds is also a common practice of weed control.
- Common salt is used for Lucerne seed treatment to control "doddar" (Cuscuta reflexa), also known as "Amar Bel."
- The ash of cow dung is dusted on the plants at the rate of 50-60 kg/ha to prevent growth of cuscuta.
- "Weed Collector", made of wood and iron is used for weed collection from the field.
- Traditional "Indigenous/desi plough" is a most common multipurpose implement.
- "Blade Harrows" is a useful implement for weeding and inter-cultivation in the standing crop.
- Weeding is done by "Kudaali/Spade or Khurpi."(Small hoe with wooden handle)
- Most farmers are aware of hand weeding/picking (64.7%) and use of ash (69.3%) the ways of controlling weeds/pests on the Farms.

The ITK that was least known to farmers was the use of goat waste (12.0%) as a weed/pest control agent. The number of goats in the study area has significantly reduced, as farmers prefer to keep cattle instead of goats. Some indigenous technological knowledge from Tamil Nadu
[http://agritech.tnau.ac.in/itk/IndigenousTechKnowledge_Oper.html#WEED%20MAAGEMENT]

1. If weeding is not done, it will reduce three fourths of crop yield.
2. Weeding is not required under dry land condition. If weeding is not done the weed growth is controlled naturally and it also helps to conserve moisture.

3. ·Repeated ploughing will reduce weed population.
4. Crop yield will be less in the fields having 'Arugu' *(Cynodon dactylon)* weeds.
5. To control "Arugu1 *(Cynodon dactylon)* grass in ' black soils the field is kept fallow for 3 years.
6. Cultivating rice once in three years in garden lands to control Arugu' *(Cynodon dactylon)* weeds.
7. 'Raising and ploughing the green manure crops tike dhaincha, *(Sesbania sp.),* kolingi *(Tephrosia purpurea)* in the field before their flowering to reduce weed population.
8. Raising *Calotropis gigantea* as a green manure to check the growth of Aarai (Mars/tea*quadrifolia)* weed.
9. Growing horse gram to control nut grass *(Cyperus rotundus).*
10. Growing cowpea as a green manure to control nut grass.
11. Allowing swine in the fields to eradicate nut grass.
12. Frequently ploughing the fields by wooden plough made up of neem trees and frequent application of neem cake in the soil to control nut grass.
13. Dissolving 1 kg. of salt and 100 g. of sarvodaya soap in 10 lit. of water and spraying this solution to control all the weeds except nut grass.
14. To control nut grass in the field 50 kg. of neem cake is applied both at the time of ploughing and sowing.
15. Dissolving 200 g. of salt in 1 lit. of water and spraying to eradicate congress weed (*Parthenium hysterophorus).*
16. Continuous submergence of field for some time controls the weeds.
17. Keeping the irrigation channels free from weeds.

Constraints associated with Indigenous Knowledg

1. The transfer and use of information is constraint and error-prone since it has to be passed orally and held in the heads of practitioner.
2. While non-availability of material input was reported as a major problem in the adoption of indigenous farm practices by a majority of small and medium farmers, non-availability of labor was a major problem to big farmers.
3. These practices, their intricacies and rationale are known to uneducated, aged people in villages. These practices are commonly found in remote villages and tribal tracts.
4. Scientists by and large have scant respect for the utility of such practices and scientific elite methods such as publication, seminar etc. are needed to create the awareness
5. Travelling to remote places, staying there, documenting the details and publication require funds.
6. While the documentation can be conveniently made in local language, later translation into English and other regional languages is needed.

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New Agriculture Reform and its impact on Peasant Economy

R. Minithra [1*], R. Suresh[2], D.Rameshkumar[3], N.Jagathjothi[4], S. Easwari[5], R.Rajesh[6], R.Muthuselvi[7], P. Naveen Kumar[8] and B. Krishnakumare[9]

1-9-Senior Research fellows, DABD, TNAU, Cbe-03
Corresponding Author: minithra436@gmail.com

INTRODUCTION

One of the biggest factors affecting the growth of agriculture sector in the country is the inability of the farmer to find a better market to get a fair price to their produce. Indian farmers were allowed to sell their produce only in designated mandis. At the mandi, they would meet with their commission agent, who would assist in selling their crops, for a fee. The commission agents would decide the prices amongst themselves, leaving farmers with no option but to sell at the set prices, all the expenses for cleaning, sorting and storage would be paid by farmers. Wholesalers and retailers were unable to buy from farmers directly. This lead to consequences such that consumers were paying higher prices, and farmers were not receiving their share.

In order to bring solution to this issues government of India came out with a new agricultural marketing reforms such has The Farmers Produce Trade and Commerce (Promotion and Facilitation) act, The Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services act, and The Essential Commodities (Amendment) act, 2020 were announced has the part of the third tranche of the economic package announced under Atma Nirbhar Bharat Abhiyan. The overall objective of the three proposed act is to make way for creating *'One India, One Agriculture Market'.*

THREE NEW AGRICULTURAL REFORMS, 2020

The Farming Produce Trade and Commerce (Promotion and Facilitation) act, 2020 aims at creating additional trading opportunities outside the APMC market yards to help farmers get remunerative prices due to additional competition. Farmers can now sell their agricultural produce in a market of their choice at better prices.The newly proposed law will allow intra-state and inter-state trade of farmers' produce beyond the physical premises of APMC markets thus giving freedom for the farmers and traders to sell or purchase farm products anywhere.Electronic trading in transaction platform has been proposed for ensuring a seamless trade electronically. The proposed law also allows private individuals, FPOs and co-ops to set up electronic trading platforms in these areas.

The Farmers Empowerment and Protection amendments, 2020, with contract farming, farmers can now negotiate directly with wholesalers, processors, retailers, and exporters. Parameters such as quality, grade, price, and quantity will all be decided upon mutually. This will provide further price security, as farmers will be assured of receivingthe agreed upon price at the time of harvest.

They will also be saved the hassle of transportation costs, as the produce would be picked up from their farms directly. Farmers will also be able to enter into agreements with farm service providers. With multiple avenues to sell their produce, price crashes will become less and less frequent.

Technology will finally reach the farmers. They will be provided with price and market intelligence. Previously, farmers never knew that the demand for their crop was present in another state or country and what prices were

being offered. They will be provided with the expected price of their crop at the time of sowing, making their decisions more informed. Before this, they would find out the trading price at mandis during the marketing season, through the trader. This will lead to increased productivity and substantial enhancement of their incomes.

The amendments to the Essential Commodities Act will prompt large-scale investments in warehouses, silos, cold storages, and creating more markets to sell produce. Under the legislation, the central government may regulate or prohibit the production, supply, distribution, trade, and commerce of such essential commodities. Essential Commodities Act to provide that stock limits for agricultural products can be imposed only when retail prices increase sharply and exempts value chain participants and exporters from any stock limit.

WAY FORWARD

Thus by focusing on enhanced productivity, better market intelligence and flow of technology, market forces will ensure our farmers' income shoot up significantly. The agricultural marketing reforms would enable to shoot ahead the development process, change the lives of farmers and provide a huge spur to the rural areas.

Impact of COVID-19 Pandemic on Bee-keeping in West Bengal

Rakesh Das[1]* and Madhumita Bhuiya[2]

[1]Department of Agricultural Entomology, Bidhan Chandra KrishiViswavidyalaya, Mohanpur, Nadia, West Bengal-741252
[2]Department of Mathematics, Syamaprasad College, Kolkata-700026, West Bengal, Under the University of Burdwan (DDE)
** Corresponding Author: rdas6907@gmail.com*

ABSTRACT

Flowers are in bloom but far away for starving bees. Across the world, honey bees are commonly used as planned pollinators along with honey production. The beekeepers of Bengal travel across the state including the Sundarban (Biosphere Reserve) along with their wooden bee hives usually starting from November up to the month of May, in order to collect the honey. But for the lockdown, started from the middle of March, 2020 due to COVID-19 in India, colonies of bees have been going without their staple diet because the keepers cannot venture into the seasonal feeding ground in the wild and the also keepers, who have already gone, get stuck there. Meanwhile a huge number of starving bees are dying from the large colonies of bees as the sugar syrup is not a viable option because of the cost. The Global brand of Sundarban's honey is beaten up and the keepers are facing financial hardship and so the financial loss to the corresponding business. Besides food production is estimated to get affected as without bees the yields of some fruits, vegetables etc. are known to decrease. The bees of Bengal, the sweet honey providers, had gone off the radar.

Key Words: Honey bees, Beekeepers, COVID-19, Lockdown, Sundarban

INTRODUCTION

Beekeeping is the science of rearing and managing of honey bees for commercial purpose. Humans are cherished with valuable hive products like honey, beeswax, propolis, bee venom, etc. with the help of bee-keeping. These products have their widespread use in different small and large scale industries in India as well as in International market. It is an agro-based activity in India, being undertaken by farmers/landless labours mainly in rural areas for income generation. Apart from bee hive products, they perform the major ecological role as pollinators and additional yield obtained due to bee pollination alone is 15-20 times more valuable than the other hive products all together. By keeping bees in field, crop yield can increase to an extent of 20-

80 per cent in most of the cultivated crops through cross pollination. Hence, in addition to 4 basic inputs viz., seed, fertilizer & pesticides, water and machinery, nowadays honey bees are considered as 5th input for agriculture production which can also regulate the efficiency of other inputs.Beekeeping has been practiced with two types of honey bees that can be domesticated namely, native one, *Apis cerana* or Asiatic or oriental honeybee and introduced one, *Apis mellifera* or European honeybee and the rests are wild, therefore untameable.

BEE-KEEPING POTENTIALITY OF WEST BENGAL

Bengal is pioneering of modern bee-keeping in India, as the first attempt to keep bees in modern movable frame hives was made in 1882 in Bengal by Mr John Douglas (Suranarayana, 1994). The major importance of bee-keeping in the state is honey production and the beekeepers are less interested in other hive products. In accordance of the potentiality of honey production, West Bengal chaired as most potential state and along with Uttar Pradesh, Punjab and Bihar share more than 50% of total honey production in India (Report of the Beekeeping Development Committee, 2019). The varied agro-climatic conditions with enrich floral diversity make the state as most potential in bee-keeping and honey production.At present there are approximate 15,000 beekeepers in the state and the honey production increases from 15,800 MT (2016-17) to 16,500 (2017-18), stands only behind UP (18,900 MT) across the country. The states derive the honey mostly from *A. mellifera* colonies while part of its honey comes from the wild bees or rock bees, *A. dorsata* particularly from Sundarbanareas. The districts with majority of beekeepers and having potentiality of bee-keeping are Malda, Murshidabad, Nadia, North and South 24 PGS, West Mednipore etc.

In Bengal, the beekeepers started bee-keeping with *A. mellifera* during early 90's when the beekeepingindustry with the native bee, *A. cerana* was badly hit because of the outbreak of Thai sacbrood virus (TSV) and gradually it occupies the dominant species for commercial bee-keeping due to having superiority (gentle with high honey yielder) over native one. On the contrary,bee-keeping with *A. cerana* in recent time stands in a very negligible form, only having of few discrete distributions, mainly in hilly areas of northern districts, little bit in western tracts and few in costal tracts of the state. Generally the migratory mode of beekeeping is practiced with *A. mellifera* where the bee boxes are shifted from one place to another depending on the availability of bee flora, resulting in the production of huge quantity of honey.

MIGRATORY BEE-KEEPING WITH APISMELLIFERA IN WEST BENGAL

Migratory beekeeping benefits in two ways, firstly shifting of boxes with onset of flowering provides good quantity of honey production and secondly, ensure optimum pollination of the respective crops resulting good yield quality. But for doing commercialmigratory beekeeping, the beekeepers have to map the floral resources available and doplan migration accordingly.

In West Bengal the honey season of bee-keeping starts from October-November and continues upto April-May, while from June to September is the dearth period of bee-

keeping. At the onset of honey season, beekeepers prepare their hives for honey collection following the migration, whereas after completing the season they come back to their steady site for the dearth period management of the colonies following artificial feeding to survive them for upcoming season. The major floral sources for honey collection through migration are Eucalyptus, Mustard, Coriander, Black cumin, Litchi, Til/sesame and Sundarbanmangroves. Tough all the beekeepers don't collect the honey from all the floral sources in a calendar season, choice depending on the availability of flowering sources and their travelling cost.

The beekeepers start their honey collection season from eucalyptus and ending it with sesame/til. The floral calendar for migratory bee-keeping in the state is as follows:

Table 1:List of floral sources for honey collection

Flowering plants	Flowering period
Eucalyptus (*Eucalyptus tereticornis*)	November - December
Mustard (*Brassic* spp.)	December - January
Coriander (*Coriandrumsativum*)	January – February
Black cumin (*Nigella sativa*)	February – March
Litchi (*Litchi chinensis*)	February - March
Sundarban mangroves	March – June
Sesame / Til (*Sesamumindicum*)	April - May

The migration not only takes place within the district but also across the districts and sometimes may also across the states. In Bengal, migration of boxes mainly confined within the southern districts of the state and rarely/minorly in the northern districts. The different locations for migratory beekeeping for the major floral sources are listed herein:

Table 2: Locations for migratory beekeeping

Flowering plants	Districts/locations
Eucalyptus	Bankura; PaschimMedinipur
Mustard	Nadia; Murshidabad; Malda; Uttar Dinajpur; North 24 Parganas
Coriander and Black cumin	Nadia; Murshidabad
Litchi	Malda; Murshidabad; Nadia
Sundarban mangroves	South 24 Parganas
Sesame/Til	Hooghly; Bankura

Sundarban Honey (Blood Honey)

The State, delighted with the Indian Sundarban, the largest contiguous mangrove forest on earth (together with Bangladesh), on the southern-most portion of the district South 24 Parganas, is a highly productive and diverse ecosystem with an aerial coverage of 9629 Sq. Km. A major portion of honey produced in the state come from Sundarban area

and this is collected from the wild colony of *A. dorsata*, which one is predominant species of this area. A large number of local people are involved in this honey collection and they are very well known as 'Mouli'in locally. In every year,human deaths are reported by wild animals' attack, particularly by the Royal Bengal Tiger while such 'Moulis' go for honey collection in forest. Thus the 'Moulis' collect the honey by rewarding their life/blood. This is one of their secondary professions, confined only for few months in a year as the flowering season in the Sundarban expands from March to June (Chowdhury et al. 2008).

Sundarban honey is very much acknowledged both in national and international market for its quality and very often it is regarded as organic one. Thus Sundarban honey gets more value in terms of price than honeys from other floral sources like eucalyptus, mustard, litchi etc. For this reason, commercial beekeepers not only from Bengal but also from the adjoining states come to Sundarban with their bee hives (mainly of *A. mellifera*colonies) to collect the honey. Even from past few years, the local 'Moulis' are being trained and encouraged about the scientific bee-keeping with domesticated honey bees by several institutes to prevent them to go and collect the forest honey taking their life in risk. Due to the factor, commercial beekeepers have to get the official permission prior to settling their boxes in the forest. Always, the beekeepers don't get permission to settle their boxes in the deep forest area and in general they install their boxes outside the forest, near the locality area. The major mangroves for honey collection are Khalsi, Goran, Keora etc. and they blossom almost simultaneously, though Khalsi flowers bloom slight earlier than others. In deep forest areas, beekeepers can collect 40-45 kg honey/bee hive (*A. mellifera*) with an average of 5-6 harvestings, whereas from the areas near locality, beekeepers can collect 10-12 kg honey/bee hive with an average of 2-3 harvestings (unpublished data).

COVID-19 PANDEMIC AND CHALLENGES IN BEE-KEEPING

The COVID-19 pandemic in India is part of the worldwide pandemic due to coronavirus disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The very first outbreak of this virus came into light on December 31, 2019 from Wuhan City of Hubei Province in China. Subsequently the disease spreadsout in more Provinces of China, and also in the rest of the world rapidly. Afterwards, the WHO declared it a pandemic. The first case of COVID-19 in India was reported on 30th January, 2020 from Keralawhen a student from university of Wuhan, China travelled back to the state. India has registeredmore thansixty lakh coronavirus caseswith more than one lakh death reports; whereas in world the total cases crossed 3.5 corers mark till date.

Worldwide lockdown strategy has been adopted to combat with this pandemic. In India the nationwide shutdown started from midnight of 24th March for 21 days and prior to it a 14-hour voluntary public curfew was observed on 22nd March, at the instance of the Prime Minister. Furthermore, the lockdown period had been increased in subsequent phases, from 15th Aprilto 3rd May for 19 days (Phase 2); followed by 4thto 17th May for 14 days (Phase 3) and 8th to 31st May for 14 days (Phase 4) with substantial relaxations in containment zone wise. After that the unlock process had been started in India

through monthly basiswith ease in restrictions from June onwards and presently unlock 5 is prevailing (for the month of October).

The nationwide shutdown, announced by the government in March to tackle the pandemic hit the bee-keeping activity very badly in West Bengal. The bee-keeping industry in our country is at its major growth phase where the Prime Minister's vision of Sweet Revolution has been taken up to encourage the bee-keeping and honey production in our country; and West Bengal shares an integral portion of this industry. The exemption of farm activities after one month of lockdown period due to the nationwide rabi season harvesting and prior preparation for monsoon cultivation, impactsquite less on agriculture as compared to other sectors. Inspite of being farm based activity, the bee-keeping still faced the major crisis during this prevailing exemption. The commercial bee-keeping in West Bengal depends mainly on the periodic migration of boxes coupling with flowering season. From the mid/end of March, flowering season in Sundarban starts and the beekeepers start to migrate their boxes to collect the renowned Sundarban honey. Meanwhile prior to migrate in Sundarban, beekeepers used to collect the honey either from mustard (late season) or coriander or litchi flowers and for this the beekeepers settle their boxes in different fields and/or orchards of Nadia, Murshidabad, Malda etc. districts. Hence the beekeepers aren't able to migrate their boxes due to the lockdown imposed and get stuck in their respective places resulting into huge economic loss. Firstly, the Sundarban honey is not collected; secondly,with the end of flowering season of crops like mustard, coriander or litchi within the March end,the survival of bees face challengesdue to starvation as the artificial feeding is not always viable option for the beekeepers which resulting into colony losses.

Many of beekeepers in West Bengal are marginal and they mostly depend on middle man locally known as 'Mahajon' from where they borrow the money for their apiary management, particularly for dearth period feeding. During the dearth (June-September), the bees are to be fed with sugar syrup as artificial feeding because of absence of natural flowers. For this purpose, the beekeepers debt the money and are liable to sale their honey to the 'Mahajon'; and even the selling price is decided according to the 'Mahajon' depending on honey quality. Thusthey don't get appropriate price and even sometimes they have to sale their honey in very low price due to their debt. In general, the Sundarban honey gets high price in compare to others like mustard honey, coriander honey, eucalyptus honey, litchi honey etc. All together, the keepers face a major economic hit due to this pandemic both in terms of honey collection as well as for colony losses.

Government Initiative

With the ease in restrictions in farming sector, Central Government also announced economic package of Rs. 1.63 lakh crore for agriculture and allied sectors aimed at strengthening infrastructure, logistics and capacity building at farm gate. The announcement was done by Union Finance minister, Nirmala Sitharaman on 15th May, 2020.In this package, an amount of Rs. 500 crore was allocated for beekeeping

initiatives with an aimed to infrastructure development related to integrated beekeeping development centres, collection, marketing and storage centres, post-harvest & value addition facilities etc. This initiative was taken in view of that it will lead to a likely increase in income for 2 lakh beekeepers and quality honey to consumers.

CONCLUSION

Globally the biodiversity sustainability and human food security are in major threat due to the declinationof pollinators. In this regard bee-keeping is an opportunistic way to meet the need in present scenario. Encourage in bee-keeping not only helps in upliftment the rural economy, but also crop productivity can increase through planned pollination service. Like other enterprises, bee-keeping also faced major threat in this pandemic situation and needs support for its survival. Government should come forward for this and take initiative for its development. The process has to be run at the end beneficiaries and officials should be aware of this particular.

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Importance of Edible wax coatings in fruits and vegetables

R. Muthuselvi[1*], P.Naveen Kumar[2], B. Krishnakumare[3], R.Minithra[4], R.Suresh[5], D.Rameshkumar[6], N.Jagathjothi[7], S.Easwari[8] and R.Rajesh[9]

Senior Research Fellow, DABD, TNAU, Cbe-03

**Corresponding author: muthuselvi.horti@gmail.com*

INTRODUCTION

Fruit and vegetables are a good source of vitamins and minerals, including folate, vitamin C and potassium. They are the excellent sources of dietary fibre, which can help to maintain a healthy gut and prevent constipation and other digestion problems. A diet high in fibre can also reduce your risk of bowel cancer.Fruits and vegetables can be classified as climacteric or non-climacteric. Climacteric fruit continue to ripen after harvest, whereas non-climacteric do not continue to ripen after harvest. Many important tropical fruits are climacteric, such as banana, mango, papaya, avocado, and guava. These fruit ripen rapidly during transit and storage, thus often requiring rapid shipment by air. There is an opportunity with climacteric fruit, however, to slow down ripening after harvest and thus, extend the shelf life. This can be done with controlled atmosphere (CA) storage, modified atmosphere packaging (MAP), or with edible coatings. In all cases the atmosphere created is that of relatively low oxygen (O_2) and high carbon dioxide (CO_2) compared to standard atmosphere. The low O_2 and high CO_2 depress ethylene production which is required to turn on ripening genes that effect color changes, aroma and degradation of cell walls results in softening.

MATERIALS USED IN EDIBLE COATINGS

Edible coatings can be formulated from different materials including lipid, resins, polysaccharides, proteins, and synthetic polymers. Most of the coatings are a composite of more than one film-former with the addition of low molecular weight molecules such as polyols that serve as plasticizers. Surfactants, antifoaming agents, and emulsifiers are also often used in coatings.Lipid materials used in coatings are generally incorporated as waxes or oils. Carnauba, candelilla, and rice bran waxes are natural plant waxes; beeswax is also a natural product; and paraffin and polyethylene wax are petroleum-based products.

For resins: shellac is a natural product from tree resin, wood resin is a waste product of the lumber industry, and coumarone indene resin is a petroleum-based

product. Lipids are excellent water barriers, but are relatively permeable to gases, and thus, not as useful to create a modified atmosphere to delay ripening. The resins are relatively good water vapor barriers, very shiny, but exhibit relatively low permeability to gases and thus can cause anerobic conditions in fruit if there is temperature abuse. Other resins include copal, damar and elimi which are only used in pharmaceuticals.

Carbohydrate materials include cellulose, starch, and pectin which are plant derivatives; alginate, carrageenan and furcellarancome from seaweed and chitosan made from the exoskeleton of crustaceans. Gums including gum arabic, gum ghatti, gum karaya and gum tragacanth are plant exudates; guar and locust bean gum are from seeds; and xanthan and gellan gum are products of microbial fermentation. Polysaccharides are not good barriers to water vapor, but exhibit moderately low permeability to gases and are useful to delay ripening of climacteric fruit.

Protein materials used in coatings include soy protein, corn protein (zein), casein and whey proteins from milk, wheat gluten and peanut protein. The wheat, milk and peanut proteins are potential allergens to a small portion of the population, which should be taken into consideration when formulating coatings. Zein can be used instead of shellac and as a group, protein materials are similar to carbohydrates in their permeability to water and gases.

Waxes

Waxes are esters of higher fatty acid with monohydric alcohols and hydrocarbons and some free fatty acids. It is used to modify the internal atmosphere and to reduce water losses of fruits and vegetables. Waxes are used only in tiny amounts. It may turn white on the surface of fruits or vegetables if they have been subjected to excessive heat and/or moisture. This whitening is safe and is similar to that of a candy bar that has been in the freezer. Commodities that may have coatings applied include apples, avocados, bell peppers, cantaloupes, cucumbers, eggplants, grapefruits, lemons, limes, melons, oranges, parsnips, passion fruit, peaches, pineapples, pumpkins, rutabagas, squash, sweet potatoes, tomatoes, turnips and yucca. The fruit waxing method can be manual or automated. During manufacturing, the waxy coating material is dispersed and dissolved in a solvent such as water, alcohol, a mixture of water and alcohol. Additives such as plasticizers, antimicrobial agents, minerals, vitamins, colors or flavours can be added in this process. The film solutions can be applied to fruits by several methods such as dipping, spraying, brushing and canning followed by drying.

Importance of waxing

1. To preserve fresh fruit quality during handling and subsequent marketing
2. To control storage atmospheric temperature
3. To extend the post harvest shelf life of fruit by reducing respiration and delaying senescence.

Principal advantages of wax application are

1. Improved appearances of fruit
2. Reduced moisture losses and retards wilting and shriveling during storage of fruits

3. Less spoilage specially due to chilling injury and browning
4. Creates diffusion barrier as a result of which it reduces the availability of O_2 to the tissues thereby reducing respiration rate.
5. Protects fruits from micro-biological infection
6. Considered a cost effective substitute in the reduction of spoilage when refrigerated storage is unaffordable
7. Wax coating are used as carriers for sprout inhibitors, growth regulators and preservatives

Disadvantage

- Development of off flavour if not applied properly
- Adverse flavour changes for inhibition of O_2 and CO_2 exchange, thus resulting in anaerobic respiration
- Thus resulting in anaerobic respiration elevated ethanol and acetaldehyde contents

TYPES OF WAXES

1. ***Solvent waxes:***Solvent waxes widely used in citrus are composed of 70 to 80 % aliphatic

Hydrocarbons and solvents such as acetone, ethyl acetate. The solvent will contain either a synthetic resin or a natural wood resin plus one or more plasticizers.

2. ***Water waxes:*** Water waxes are a second major type. The most extensively used being resin solution waxes and emulsion waxes. Resin solution waxes are simply solution of one or more alkali –solube resin or resin-like materials such as shellac, natural gums or wood resins. Emulsion waxes are composed of a natural wax such as carnauba or paraffin or synthetic wax such as polyethylene emulsion

3. ***Paste or oil waxes:*** These are mainly composed of paraffins that are different in melting point and blended to give a desired viscosity. These are often used on vegetables

Categories of wax according to their use

1. **Storage wax**: when fruit is not to be marketed immediately
2. **Packout wax**: when fruits are to be marketed immediately
3. **High shine wax**: for giving a very high grace on market demand

Waxes used commercially

1. Paraffin wax
2. Carnauba wax
3. Bee wax
4. Microcrystalline waxes
5. Shellac wood resins
6. Polyethylene

Application methods

Manual rubbing: The process is performed by applying the wax coating over fruit surface using a brush with soft bristles or absorbent cloth. After application of edible

wax, the fruits are air dried for about 15 min. it is a time consuming process and also requires man power.

Dipping: The dipping method for fruit waxing is used when the fruits are coated with paraffin wax. The fruits are dipped in melted paraffin wax coat for about a second. The paraffin solidifies immediately on fruit's surface after it is removed from wax bath.

Brushing: This is an automated method of fruit waxing. The liquefied wax is dispensed over the brush that continuously applies a thin layer of wax coating over fruit surface. The wax can be sprayed using a pump through low pressure nozzles.

Harmful effects of eating wax coated fruits and vegetables

The fruit waxes mixed with additives such as glycerols, lactic acid or acetic acid to adjust the pH of coating material. In addition, the fruit waxes may also contain traces of preservatives, antimicrobial agents and texture enhancers.Morpholine is present in most fruit waxes to give thin and even films. The safe dose of morphine in humans is 4.3ng/kg body weight/day. Repetitive consumption of morpholine as well as some other chemical agents present in fruit waxing can be hazardous to health.

RISK OF CANCER

Morpholine is used commonly as a solvent and emulsifier in making the wax coatings for fruits and vegetables. Morpholine by itself in the doses that are present in fruits and vegetables does not constitute a health risk. However inside the body when it comes in contact with nitrate, it forms Nitrosomorpholine (NMOR) a genotoxic carcinogen that poses a risk of liver or kidney cancer.

Risk of liver and kidney damage

Experts report that on oral and pareteral administration or after inhalation, morpholine is well absorbed and is distributed in the body fluids. Ingestion of morpholine through daily consumption of wax coated fruits can affect liver and kidney function.

Allergies

Many edible coatings are made from ingredients that could cause allergic reactions. These allergens include protein substances such as soy, whey protein, casein and peanut proteins.

SRI: A methodology for climate smart Agriculture

N.Jagathjothi[1]*; S.Easwari[2]; R.Rajesh[3]; R.Muthuselvi[4]; P.Naveen Kumar[5]; B. Krishnakumare[6]; R.Minithra[7]; R.Suresh[8] and D.Rameshkumar[9]

[1-9]Senior Research Fellow, Directorate of Agribusiness Development, TNAU, Coimbatore -3

**Corresponding author: jothinarayanan2000@gmail.com*

Rice is the staple food for nearly 30million people in the world creates itthe most vital food crop for human beingeating and food safety. After Green Revolution, the world rice production nearly doubled through modern cultivars quick to respond to increased external inputs like chemical fertilizer, irrigation water and pesticides. This intensive technology prevented poor farmers from completely adopting modern production technologies and also damaged soil biota and build environmental pollution.In Addition to that climate change is a burning topic in global level by which agricultural production is harmfully got affected and then livelihoods of our population is at risk.Under this adversecondition,adoptions of better technology or methodology are necessary to overcome the ill effects and achieve maximum crop productivity. Therefore, practicing of System of Rice Intensification (SRI) is one of the methodologies as climate smart agriculture for better crop production (especially in rice).

SRI principles

SRI is a novel method comprising uncomplicated management practices which enables farmers to obtain more productive phenotypes from any rice genotype (variety) by applying lessrather than with more external inputs by following principles,

- Using young seedlings between 12-14 days old (2-3 leaf stage) for earlytransplanting to keep potential for tillering and rooting ability.
- Careful transplanting of single seedlings rather than in clumps that are often plunging in the soil.
- Ensuring wider spacebetween seedlings at 25 x 25 cm in square planting rather than in rows.
- Use of cono-weeder/ rotary hoe/power weeder to aerate the soil as well as controlling weeds.
- Alternate wetting and dry method rather than continuous flooding in the field.
- Preferableuse of organic manure or vermicompost or FYM.

SRI benefits

Father de Laulanie developed SRI at Madagascar in 1980s. He said SRI is an amalgamation of multiple beneficial practices.

The benefits realized by adoption of SRI are listed as follows,

- Large root volume
- Profuse and strong tillers with non lodging character
- Big panicles with more and well filled grain
- Higher grain weight and head rice recovery
- Higher grain and straw yield
- Reduced duration
- Lesser chemical inputs
- Less water requirement
- Resist to pest and insects
- Soil health improves through biological activity
- Withstand cyclonic gales&cold tolerance

Particularly SRI method of cultivation recorded less carbon footprint that is emission of green house gases which are the causes for global warming and led to climate change.

SRI is need of hour

Today agriculture faces many challenges. Among that the major facts are,

- Needs to enhance food production sustainably to feeda growing world population.
- Increased production needs to be accomplished under conditions ofincreasing scarcity of water and land resources.
- Risk in adoption of intensive technology by poor small and marginal farmers.
- Soil degradation and polluted environmental condition.
- At present the farmers need to cope with climate change and variability.

All the above sources of vulnerability except climate change are endemic to agricultural pursuits. Hence, agricultural practices can be altered appropriately to deal with changing weather patterns.Farmers can adapt their farming systems to gradual upward trends in temperature and even to incremental average annual changes in precipitation like extreme events. Droughts,floods, cold snaps, heat waves, typhoons and other kinds of storms, alldisruptive of agriculture, can have disastrous impacts on production.

SRI methods decrease the susceptibility of rural domestic in several ways, initially by dropping procured inputs. Also changed management practices of plants, soil, water and nutrients help to enhance plants root growth and functioning which

results in the number and diversity of soil biota. SRI diminishes household menace by giving better resistance to biotic and abiotic stresses that can lower crop yield.

Prof Uphoff told as in the 21st century, water becoming an important cost and constraint with soil degradation and shrinking land resources and climate change adverse impacts, SRI offers better opportunities for millions of farming community.

CONCLUSION

Apart from rice growers can also benefit from the concepts and methods associated with SRI by extrapolating them to other crops such as finger millet, wheat, sugar cane and vegetables. Therefore, to meet future food needs, it is essential to reduce factors used in production such as land and water, while increasing productivity. A well-designed up scaling strategy and the potentially promising SRI method boosted and sustained the production of rice; it also helped the build-up of organic matter and improved soil fertility. By which it offers an attractive opportunity for increasing food production per unit of water and improving efficiency.As a whole SRI methodology considered as highly effective practiceunder climate smart agriculture.

Vertical Farming - Agriculture of the Future

D. Rameshkumar*, N. Jagathjothi, S. Easwari, R. Rajesh, R. Muthuselvi, P. Naveen Kumar, B. Krishnakumare, R. Minithra and R. Suresh

**Corresponding author: rameshhorts@gmail.com*

INTRODUCTION

In 1915, Gilbert Ellis Bailey coined the term "Vertical farming" and wrote a book titled "Vertical Farming". In the early 1930s, William Frederick Gerick pioneered hydroponics at the University of California at Berkley. In the 1980s, Ake Olsson a Swedish ecological farmers, invented a spiral-shaped rail system for growing plants and suggested vertical farming as a means for producing vegetables in cities. Using advanced greenhouse technology such as hydroponics and aeroponics, the vertical farm could theoretically produce fish, poultry, fruit and vegetables (Despommier, 2010). His concept was to grow the food in urban areas itself utilizing less distance and saving the time in bringing the food produced in rural areas to the cities. He intended in growing food within urban environments and thus have fresher foods available faster and at lower costs.

Why vertical farming?

Vertical farming could enable food production in an efficient and sustainable manner, save water and energy, enhance the economy, reduce pollution, provide new employment opportunities, restore ecosystems, and provide access to healthy food. In a controlled environment, crops will be less subject to the infestation, the nutrient cycle, crop rotation, polluted water runoff, pesticides and dust (Touliatos *et al*., 2016).

Vertical farms also utilize advanced technologies and intensive farming methods that can exponentially increase production. Researchers have been optimizing indoor farming by calibrating, tuning and adjusting a wide-range of variables including light intensity, light color, space temperature, crop and root, CO2 contents, soil, water, and air humidity (Padmavathy *et al*., 2016). In addition, vertical farming provides an opportunity to support the local economy. Abandoned urban buildings can be converted into vertical farms to provide healthy food in neighborhoods where fresh produce is scarce.

World Scenario

Vertical farming involves growing crops vertically in controlled atmosphere using technology like LED lighting, heating, ventilation and air-conditioning (HVAC) systems,

sensors and smart software, Internet of Things (IOT), drones, mobile apps to maintain total control over the environment. Food crops can be cultivated easily in urban areas by planting in vertically stacked layers in order to save space and use minimal energy and water for irrigation. Sparks and Stwalley, 2018 tested the Nutrient film technique hydroponics system was by growing lettuce plants and monitoring energy use throughout the growth period..

Various experiments are being done about vertical farming all over world. It has already been introduced in the US and Europe, Spain, Japan and Singapore. Several tech-enabled vertical farms like Aerofarms and Green Sense in the USA, Delicious in The Netherlands, Sharp's strawberry farm in Dubai, Spread, Toshiba and over 100-plus vertical farms in Japan, Packet Greens of Singapore, the EU funded INFARM in Berlin are proven examples of successful vertical farming. INFARM is now operating more than 50 farms across Berlin in supermarket aisles, restaurant kitchens and distribution warehouses. The National Aeronautics and Space Administration (NASA) researchers have seen hydroponics as a suitable method for growing food in outer space. They have been successful in producing vegetables such as onions, lettuce, and radishes. In Columbia, Association for Vertical Farming is working on its sustainability.

Categories of vertical farming systems

Vertical Farming systems can be broadly divided into two categories those comprising multiple levels of traditional horizontal growing platforms and grown on a vertical surface. Horizontal growing system are stacked horizontal systems and multi-floor towers, Balconies. Vertical growth surfaces are green walls and cylindrical growth units.

General Structure of Vertical Farming

The vertical farm is planned to be totally using artificial light or both artificial and natural light should be taken into account. The same issues need to be considered in designing the facility. There are two options available LED (light emitting diode) or HPS (high-pressure sodium). When choosing the crops to grow considering which plants can be better bred indoors. Because of limitations imposed by height, plants that grow on trees such as bananas, olives, avocados, and nuts are hard to grow inside. But, there is another chance to grow tree crops and that is to grow them in an outer area as much as there is space provided. This way, more than three dozen types of vegetables can be chosen to grow inside the building hydroponically (Ankri, 2010). The most common products now produced in vertical farms are lettuce, tomato, chinese cabbage, eggplant, green onion/chives, kale spinach and cucumber.

SYSTEMS OF VERTICAL FARMING

1. Hydroponics

"Hydroponics" is the growing of plants in a liquid nutrient solution with or without the use of artificial media. Commonly used mediums include expanded clay, coir, perlite, vermiculite, brick shards, polystyrene packing peanuts and wood fiber.

Hydroponics has been recognized as a viable method of producing vegetables (tomatoes, lettuce, cucumbers and peppers) as well as ornamental crops such as herbs, roses, freesia and foliage plants.

The predominant growing system used in vertical farms, hydroponics involves growing plants in nutrient solutions that are free of soil. The plant roots are submerged in the nutrient solution, which is frequently monitored and circulated for maintaining correct chemical composition. This method results in more uniform and better yields the optimum combination of nutrients can be provided to all plants. It also provides less labour intensive way to manage larger areas of production. It is a cleaner process that no animal excreta are used. Easier way to control nutrient level and pH balance. In 1950 commercial farms are started at America, Europe, Asia, Africa, Japan most successfully practiced in Israel.

Liquid systems have no supporting medium for the plant roots; whereas, aggregate systems have a solid medium of support. Hydroponic systems are further categorized as open (once the nutrient solution is delivered to the plant roots, it is not reused) or closed (surplus solution is recovered, replenished, and recycled).

Liquid Hydroponic / Nutrient Film Technique

Plants are placed in a polyethylene tube that has slits cut in the plastic for the roots to be inserted. Nutrient solution is pumped through this tube.

Floating Hydroponics

Plants are grown on a floating raft of expanded plastic.

Aggregate Hydroponics

Rockwool Culture: It is the most widely used medium in hydroponics. Rockwool is ground-up basalt rock that is heated then spun into threads making wool. It is very light and is often sold in cubes. Rockwool can hold water and retain sufficient air space (at least 18 percent) to promote optimum root growth. Plants are established on small rockwool slabs positioned in channels containing recycled nutrient solution.

These system are further categorized into two:

- Passive systems use a wick and growing media with very high capillary action. This allows water to be drawn to the plant roots. The Wick System is by far the simplest type of hydroponic system
- Active systems work by actively passing a nutrient solution over your plants roots.

2. Aeroponics

The Aeroponic System is probably the most high-tech type of hydroponic gardening. A timer controls the nutrient pump. The aeroponic system needs a short cycle timer that runs the pump for a few seconds every couple of minutes. In aeroponics, there is no growing medium and hence, no containers for growing crops. In this system, mist or nutrient solutions are used instead of water. As the plants are tied

to a support and roots are sprayed with nutrient solution, it requires very less space, very less water and no soil.

Advantages of vertical farming

- The first and the major advantage of vertical farming is producing extremely high yields per available land or area.
- Producing the food throughout the year without the risk of vagaries of nature of nature like floods, heavy rains, uneven rains, hail and snowfall, drought, dry spells, extreme high temperatures, cold waves, epidemics of pest and diseases, etc.
- It reduces the cost over transporting loads of food grains from rural area to urban areas and reduce the spoilage occurring there in. Fossil fuel consumption in transporting the farm produce to cities from village places is also reduced to a greater extent.
- Vertical farming uses 70 to 95 % less water compared to traditional farming
- 90% less or no soil is needed in vertical farming and thereby no pest and disease infestations.
- Pesticide free or organic food is produced as there is no use of pesticides.

Disadvantages of vertical farming

- Initial huge cost for establishing the vertical farming system is the major problem. It will include the cost erecting the structures along with its automation like computerized and monitoring systems, remote control systems, programmable LED lighting systems, climate control system, etc.
- Huge energy cost as growing plant is entirely with artificial lights. The excess nutrients used in vertical farming may interfere and contaminate the main urban water system if not taken care of.
- LED lighting systems emit heat though small amount will create problem of maintaining the temperatures especially in summer months and may overload the air conditioning systems which will again incur high energy cost.

FEASIBILITY OF VERTICAL FARMING IN INDIA

India is one of the largest producer of vegetables, fruits and many other agricultural commodities. In India, vertical farming has been introduced. ICAR experts are working on the concept of 'vertical farming' in soil-less conditions, in which food crops can be grown even on multi-storeyed buildings in metros like New Delhi, Mumbai, Kolkata and Chennai without using soil or pesticides. Small-scale adaptations of vertical farming have been seen in Nadia, West Bengal and in Punjab. Bidhan Chandra Krishi Vishwa vidhalaya in Nadia has found initial success in growing brinjal and tomato. Punjab also has succeeded in producing potato tubers through vertical farming (Kalantari *et al*., 2018).

FUTURE THRUST

- ❖ If vertical farms were integrated in the city, they will be able to supply food for the entire population.
- ❖ There is a need for research that accurately assesses the Return of Investment (ROI) of various types and sizes of vertical farms.
- ❖ There is a need to investigate the full life-cycle analysis (LCA) and the number of years to reach parity with a traditional farm
- ❖ Researchers should invent, advance, and further develop local farming techniques to make vertical farm projects feasible in these countries.
- ❖ For example, they may invent recycling methods that reduce reliance on water, design local systems by capturing rainwater, and may capitalize on local solar power for providing natural light and energy (Kalantari *et al*., 2015).

CONCLUSION

Vertical farming is a best alternative for the city dewellers. It can deliver food in sustainable ways to improve global food security and solve the environment degradation problems. No harvest would fail by severe weather phenomenon. It has the benefit for easily minimise the cooling and heating water by indoor temperature. It helps to reduce poverty, increase food safety and well being of human. Effectiveness of vertical gardening depends on the demand and supply of food, urban population and densities, technological development, water and energy supply and weather conditions.

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Actinobacteria for Sustainable Agriculture

R.Rajesh[1]* R.Muthuselvi[2], P.Naveen Kumar[3], B.Krishnakumare[4], R.Minithra[5], R.Suresh[6], D.Rameshkumar[7], N.Jagathjothi[8] and S.Easwari[9]

[1]Dept of Agricultural Microbiology, TNAU, Coimbatore-3,
[2-9]Directorate of Agribusiness Development,TNAU, Coimbatore-3

** Corresponding Author: rajeshramasamyk@gmail.com*

ABSTRACT

Agriculture is an elaborate interacting network of plants and microorganisms. A group of obscure microorganisms that interact with plants in soil to deliver beneficial effects are designated as Agriculturally Important Microorganisms, which are sometimes difficult to predict. They preserve the natural ecosystem resources under climate change by efficient utilization of nutrients and recycling of energy in soil. Actinobacteria plays a pivotal role in nutrient management, decomposing organic matter, and recycling of organic residues. The major reason behind such important roles of the organisms in the soil and plant relationships emanates their ability to manufacture plenty of secondary metabolites, have constructive uses like plant growth regulation, bio controlling etc. Hence, the prospecting and exploitation of useful microbes and their bio-inputs might be a suitable option for promoting crop production.

Keywords: Actinobacteria, Biofertilizers, Siderophores, Biocontrol, Sustainable agriculture

INTRODUCTION

One of the most fascinating group of organisms' actinobacteria or actinomycetes comes under largest taxonomic units within the domain bacteria. The word "Actinomycetes" are originated from "atkis" (a ray) and "mykes" (fungus), Greek words, because they having the features of both bacteria and fungi. They are the potential producers of several secondary metabolites, include antibiotics, immunosuppressive agents, antitumor agents, and enzymes (Chaudhary*et al*. 2013).Actinobacteria is a phylum and class of Gram-positive bacteria. The phylum Actinobacteria are classified into six classes namely Acidimicrobiia, Actinobacteria, Coriobacteriia, Nitriliruptoria, Rubrobacteria and Thermoleophilia. Actinomycetes displays a range of unique prokaryotic life cycle

and play an important role in organic matter recycling of soil ecosystem. They are the most abundant soil organisms, produces a characteristic "earthy smell" because the existence of metabolite "geosmin" and grows as thread-like filaments in the soil (Sprusansky*et al*. 2005). Although the *Streptomyces* genus is recognized as the largest reservoir of natural bioactive products (Terkina*et al*. 2006). About 75% of available natural antibiotics are produced in the members of genus *Streptomyces*. The Actinobacteria also plays an important role in mitigation of different abiotic stress conditions in plants.

ACTINOBACTERIA IN AGRICULTURE

In modern agriculture, there are a lot of challenges especially in developing countries, where the fast growing population increases the demand for food grains and the need for trading and economic development increase the demand for various cash crop products. Another challenge the modern agriculture faces is the emergence of many phytopathogens that pose serious threat to productivity and quality of the products produced. These challenges are contained to a great extent by the usage of fertilizers and chemical agents like fungicides, insecticides, etc. While on one hand these chemicals help farmers reap benefits, there is always a negative side to excessive usage of chemicals in agricultural fields. The major downside is that the chemicals often deplete the soil of its fertility and natural composition, thereby making it sterile and lose its natural biodiversity and beneficial microorganisms. Also biomagnification and residual activity of these chemicals pose serious threats to human health. In order to replenish the soil with its natural fertility, it is essential to reintroduce the beneficial bacteria in the soil.

Actinobacteria can be utilized as biofertilizers for sustainable agriculture as they can enhance plant growth and soil health though different plant growth promoting attributes such as solubilization of phosphorus, potassium and zinc, production of Fe-chelating compounds, phytohormones hormones such indole acetic acids, cytokinin, and gibberellins as well as by biological nitrogen fixation. The members of phylum Actinobacteria exhibited the multifarious plant growth promoting attributes and could be used as biofertilizers for crops growing under natural as well as under the abiotic stress conditions for plant growth and soil health for sustainable agriculture.

In the last few years, Actinobacteria gained much attention are also included in the category of plant growth promoting rhizobacteria (PGPR), free living agriculturally important bacteria, due to its robust antimicrobial potential, and dominant soil saprophytic nature (Franco-Correa *et al*. 2010). These bacteria have voluminous beneficial properties on agricultural production by overwhelming microbial plant pathogens, improving nutrient availability and increasing assimilation. Hence, the use of plant growth promoting Actinobacteria (PGPA) diminishes the negative impact of inorganic fertilizers, thus by improving crop quality, fertility and yield. Actinomycetes are actively involved agricultural productivity by production of plant growth promoting substances such as plant hormones, siderophores etc. and actively involved in increasing soil fertility and in stress alleviation.

PLANT GROWTH PROMOTION BY ACTINOMYCETES

The most abundantly occurring Actinomycete in soil is *Streptomyces.* The genera, *Nocardia, Micromonospora* and *Streptosporangium* are less abundant Actinomycetes. Actinomycete species can grow in close association with plant roots and they are one of the most important root colonizing organisms, especially *Streptomyces.* Their thread-like filamentous colonial morphology helps them to colonize the rhizosphere area efficiently, which in turn enables to establish host - rhizobacteria symbiosis very effectively. After they establish effective colonization, the Actinomycetes are able to produce many organic compounds and enzymes that are beneficial to plants (Table 1). The ability to produce these compounds enables the actinomycetes to break down complex organic matter in the soil into simpler forms for the plants to absorb easily. Also they have many pathways to produce plant growth promoting compounds such as IAA, Siderophores, etc. It has been reported that around 60% of insecticides and bioactive compounds were discovered in the past 5 years from Actinomycetes especially *Streptomyces* sp (Pahari*et al*. 2016).

Table 1. Enzymes and compounds produced by various Actinomycete species

S.No	Enzymes and compounds	Actinomycete species
1	Chitinase	*Streptomyces viridificans, S. coelicolor, S. griseus, S. albovinaceus, S. caviscabies, S. viginiae*
2	Cellulase	*Thermonospora* spp. *Actinoplanesphilippinensis, A. missouriensis Streptomyces clavuligerus*
3	Peptidases	*Nocardia*spp
4	Proteases	*Nocardia* spp. *XylanasesMicrobiospora* spp.
5	Lipases	*Streptomyces* spp.
6	Amylases	*Thermomonosporacurvata*
7	Lignases	*Nocardiaautotrophica*
8	Nitrogen fixation	*Frankia* spp.
9	Phosphate Solubilization	*Micromonosporaendolithica*
10	Plant hormone-like compounds	*Streptomyces hygroscopicus*

ActinobacterialSiderophores in Crop Protection

Actinobacteria is one the supreme group of microorganism involved in siderophores production. An endophytic*Streptomyces*sp obtained from the rhizosphere of a Thai jasmine rice plant produced considerable amount of Siderophore prompted plant growth and evidently raised root- shoot lengths and biomass (Rungin*etal*. 2012). Actinobacterial strains such as *Thermobida* and *Streptomyces* MCR3 synthesis a great amount of hydroxamate-type siderophores using the glucose as the sole carbon source. The plants also have a mechanism to increasing the structure of microbial community around the root soil areas. They synthesize certain phenolic exudates from roots that

enhances the development of additional siderophore secreting microbes. This improves the iron solubility and moreover enhances iron uptake in plants.

Table 2.Various Actinomycete species showing biocontrol activity against phytopathogens

Biocontrol Activity	Actinomycete Isolate
Biocontrol of Rice fungal pathogen	*Streptomyces vinaceusdrappus*
Biocontrol of *Verticillium* sp. in cotton	*Streptomyces netropis*
Biocontrol of *Phytophthoracinnamomi* in Snapdragon and Banksia	*Actinomadura* sp., *Micromonosporacarbonacea*
Biocontrol of *Fusariumudum* in cotton	*Micomonosporaglobosa*
Biocontrol of *Pythiumultimum* causing damping off disease	*Streptomyces griseus*
Biocontrol of *Fusariumoxysporum* wilt disease	*Nocardia levis*
Biocontrol of *Phytophthoramegasperma* in soybean	*ActinoplanesMissouriensis, A. utahensis, Amorphosporangiumauranticolor*
Biocontrol of *Pythiumaphinidermatum*	*Actinoplanes* sp.
Biocontrol of *Alternariaalternata* leaf blight disease in groundnut	*Streptomyces violarus*

CONCLUSION

Actinobacteriahave proved to be effective in a multidimensional way. They involve in various plant growth promoting activities such as IAA production, siderophore production, phosphate solubilization, Nitrogen fixation, complementing VA Mycorrhizal fungi and also balancing out the ecological balance in the soil system. All these qualities of this special group of bacteria make them inevitable tools in increasing agricultural productivity and quality. Considering all these aspects, it is high time that we focus on Actinomycetes as alternative tool for reducing harmful chemical usage to promote eco-friendly and sustainable farming practices. These bacteria have voluminous beneficial properties on agricultural production by overwhelming microbial plant pathogens, improving nutrient availability and increasing assimilation. Hence, the use of plant growth promoting Actinobacteria (PGPA) diminishes the negative impact of inorganic fertilizers, thus by improving crop quality, fertility and yield.

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Does Organic Farming Really Leads To Sustainability?

B. Krishnakumare*[1], R.Minithra, R.Suresh, D.Rameshkumar, N.Jagathjothi, S.Easwari, R.Rajesh, R.Muthuselvi and P.Naveen Kumar

[1]*Directorate of Agribusiness Development, Tamil Nadu Agricultural University, Coimbatore – 03.*

** Corresponding Author: bkrishnakumare@gmail.com*

Organic farming is basicallyallied with food safety,environmentally friendly and ethical farming practices- but is this indeed? Not long ago, organic farming has been the bull's eye, raising doubts about it being actually sustainable. Against the ever-growing global population and increased demand for food, will organic agriculture rise to the challenge?

What is organic farming?

Conventional farming involves the use of chemical pesticides, fertilisers and monoculture. These practices decrease soil biodiversity, lead to land degradation and chemical pollution which have negative social and economic impacts. On the contrary, organic farming methods aim to protect soil biodiversity and maintain various nutrient cycles found in healthy soil which in turn prevent land degradation. However, organic farming may also result in nutrient depletion, leading to a loss in productivity. If this is the case, then this would claim organic farming unsustainable.

Contribution to Global Warming

Organic farming may actually contribute more to global warming than conventional farming. As it does not use chemical fertilisers, organic farming requires more land to produce the same number of commercial crops compared to conventional farming. The need of additional land inadvertently leads to deforestation in many parts of the world as compensation for the reduced, leading to more greenhouse gas emissions.

Implications for Farmers

Almost four years ago, Sikkim converted fully to organic farming to provide safer food by means ofeco-friendly farming methods. Nevertheless, farmers have been

struggling to deal with with reduced yields after switching to organic farming. (Fig.1)This is the result of increase in disease outbreaks and pest attacks on crops. Also, the farmers complained about not receiving enough guidance and assistance from the government on how best to manage their organic farms.

In response to the widespread challenge of increased pests and diseases, Department of Horticulture, Sikkim claimed that they can never become self-sufficient in food. In order to maintain food security, the state relies on conventionally-grown food crops from West Bengal.

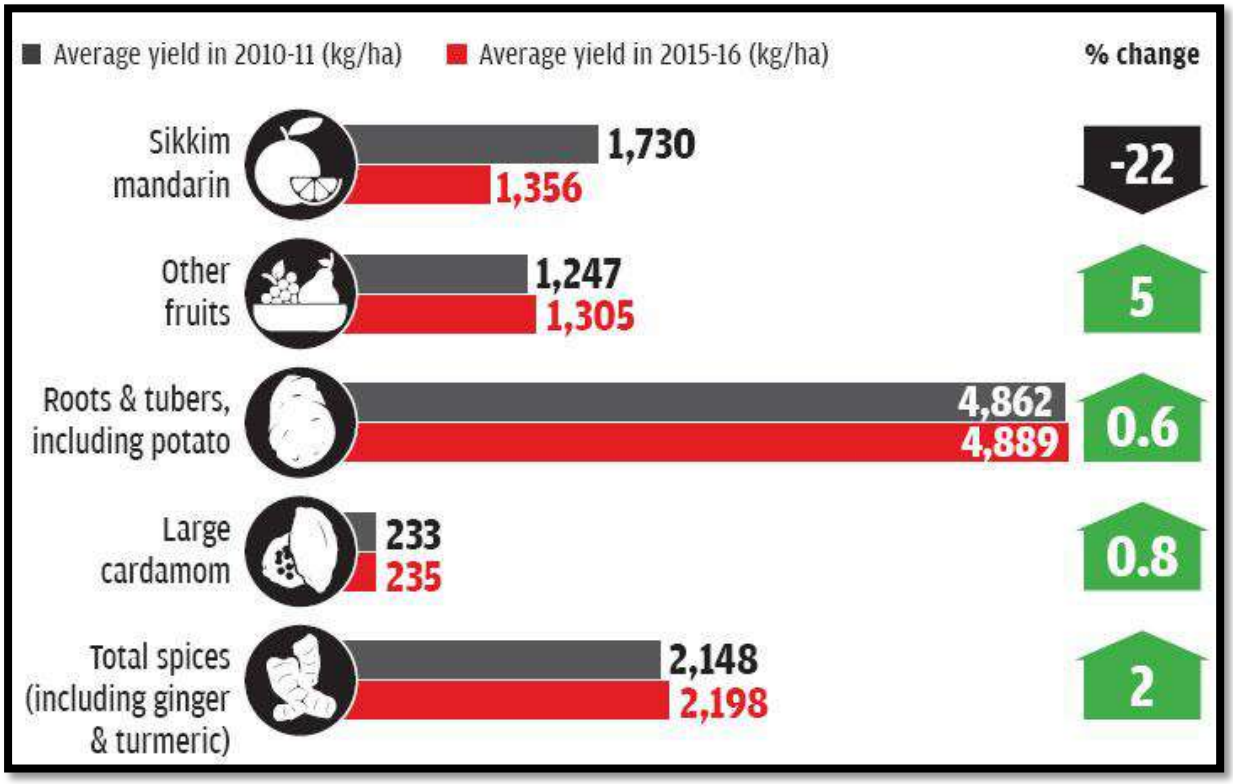

Fig. 1 Change in productivity before (in grey) and after (in red) converting to organic farming in Sikkim

Another implication of organic farming is the products' higher prices compared to those of conventional farming. According to a Consumer Reports study, one head of organic iceberg lettuce cost at least one and a half times more than its conventional counterpart in two of the three grocery stores surveyed. In light of this, not everyone will benefit equally from organic farming, especially in developing countries.

Alexander Ruane, a research scientist at the NASA Goddard Institute for Space Studies and Columbia University's Centre for Climate Systems Research, clarified that *"the goal of organic farming in developed countries currently is about meeting the needs of those who can afford to buy the highest quality food. If this luxury interferes with the need to feed the entire population, then the country would have the potential for conflicts."*

Further, organic farming is in the notion that, as it doesn't use fertilisers or pesticides, the food is healthier. This may not always be the case. Organic crops may have to cope with more weeds and pests than conventional crops, so they may produce more natural toxins toward the weeds off, as potatoes do with a chemical called

solanine. Additionally, the use of manure fertilisers may increase the risk of contamination by microbes such as *E. coli*.

NEED FOR A NOVEL SYSTEM

It is clear that organic farming has benefits, however it needs to be revolutionised to meet the growing demands of the global population and the environment. The development of this new system would need to maintain a careful balance between the needs of society- especially the marginalised- and that of the planet.

Product diversification in Plantation crops

R. Suresh[1]*, D. Rameshkumar[2], N. Jagathjothi[3], S. Easwari[4], R. Rajesh[5], R. Muthuselvi[6] , P. Naveen Kumar[7], B. Krishnakumare[8] and R. Minithra[9]

[1-8]Senior Research Fellow, Directorate of Agribusiness Development, TNAU, Coimbatore -3

**Corresponding Author: spicessuresh005@gmail.com*

India is endowed by Mother Earth with a wide range of plantation crops, which serve up as the source for diversified products of commercial importance. Plantation crops are cultivated an extensive scale in large contiguous area owned and managed by an individual or company. In India tea, coffee, rubber, cashew, cocoa, coconut, arecanut and oil palm are the major crops grown on a plantation sector. Plantation crops plays an important role in our Indian agricultural economy and a significant driving force for growth and development of the economy of many states in our country. Export trade of many developing and developed countries with the World Trade Organization giving greater emphasis on agriculture, the commercial aspects of growing these crops take for granted considerable economic significance. Product diversification of plantation crops through value addition seems to be an important approach to mitigate the impacts of low market price and high production costs.

PRODUCT DIVERSIFICATION

Product diversification is a policy employed by a company to enlarge the productivity and attain higher sales volume from innovative products. This diversification can take place at the level of commerce and commercial level. The plantation crop products contribute a significant amount to the foreign exchange and the magnitude of direct and indirect employment to provide by the sector makes it vital for overall economic development and the products are high value of commercial which play an important role in the Indian agricultural economy.

COCONUT

It has a large potential for varied use and considered to be the most important and useful among the tropical palm. Almost all the parts of coconut are useful for both domestic purpose and in industrial units and it is called 'nature's supermarket'. Coconut is a smallholder crop and millions of rural people depend on it for survival. Its

development particularly in postharvest activities could be the base for rural development in the coconut producing countries.

The utilization point of view in coconut products can be grouped as food products *viz.,* wet meat or kernel; coconut milk, coconut jam, coconut syrup, coconut skimmed milk coconut flour, desiccated coconut, coconut chips, coconut shreds. coconut water and its product; coconut water, nata de coco, coconut toddy, neera (Coconut Flower Sap), copra, snowball, coconut oil, virgin coconut oil, coconut cake are the expediency coconut products and some by-products are nonfood products *viz.,* coconut husk, composted coir pith – a good manure, shell products *viz.,* Charcoal and activated carbon and coconut shell handicrafts. Coconut fiber *viz.,* Coir and coir products, mats, brushes, brooms and rubberized coir mattresses and miscellaneous products are Coconut wood is currently used as substitute for conventional wood. Coconut leaves and midribs are used in different purposes for making broom, basket, and handicrafts. For coconut-based oleo chemicals including fatty alcohol, fatty acids, methyl esters, tertiary amines, alkanolamides and glycerine, there has been a growing demand in the world market.

Arecanut

Arecanut (*Areca catechu* L.), have great potential at international market as foreign exchange earner. India is the largest producer of areca nut in the world. The products of arecanut, *viz.,* fat, alkaloids, tannins and areca husk, have alternate uses with the potential for establishing small-scale industries.

Cashew nut

Cashew nut (*Anacardium occidentale* L.) is an export-oriented crop grown for its nut. The by-products of cashew, viz. cashew nut shell liquid (CNSL), shell cake, testa and cashew apple, are commercially exploitable. CNSL has always been credited with words such as 'versatile raw material'. Cashew apple is a rich source of vitamin C, organic acids, antioxidants and minerals.

Oil palm

The oil palm (*Elaeis guineensis* Jacq.) is recognized as the cheapest edible oil yielding crop. Main applications of palm oil are in edible food industry field mainly as solid fat for margarine, shortening and cooking oil. No edible applications including soaps, oleo chemical production and automobile energy sources are substantial and enlarging day by day. The relationship between value addition technologies, farm and agro-food processors may provide leeway to improve profitability.

Tea

Tea (*Camellia spp.*) is most consumed drink in the world after water. Tea industry makes a vital contribution to the economy of the producing countries. Tea is a rich source of polyphenols and current interest in the possible health benefits of polyphenols, particularly flavonoids has increased owing to their antioxidant and free-

radical scavenging abilities. Tea products are tea tablet, tea cola, tea toffee, tea ice cream, tea concentrate, tea wine, apple tea, tea based herbal mouth freshener, tea polyphenols and theaflavins, organic tulsi green tea, organic tulsi lemon ginger green tea, hygienically packed ice tea, hygienically packed masala black tea, soya drink with green tea, bergamot orange blend black tea are the convenience tea products and some different type of tea preparations like tea jelly and tea dish green salad.

Coffee

Production of fuel pellets or briquettes, production of a spirit beverage, substrate for edible mushrooms production, source of natural phenolic antioxidants, production of reusable cups, substrate for biogas and alcohol production, biodiesel production or composting and as well as a biomaterial in the pharmaceutical industry from coffee cherry husks, coffee pulp and coffee silverskin.

Cocoa

Cocoa (*Theobroma cocoa* L.) has been cultivated mainly for the beans. The beans make up about 33% of the fruit by weight. There are many others by products of cocoa that could be generated from the rest of the fruit and that could form the basis of small and medium scale industries in cocoa producing countries.

A feasibility study, conducted as part of the ICCO/CFC/COCOBOD-funded cocoa by products project, indicated that there is the potential for cocoa farmers to enhance their incomes through the processing of cocoa waste into the developed by-products in all cases except the production of industrial alcohol, which only results in an unattractive 3% enhanced income. The other products result in an enhancement of revenues ranging between 13% and 18%.

Cocoa bean shell - The major use of cocoa bean shell is as mulch. This mulch contains approximately 2.5% nitrogen, 1% phosphate and 3% potash as well as a natural gum that is activated when watered. Cocoa butter extracted from discarded cocoa beans.

Other cocoa products

Sl. No	By-product	Source
1	Cocoa gum	Pod husk, leaves, and chupons
2	Dietary	fiber shells
3	Methylxanthine	Shells, leaves, beans, and chupons
4	Theobromine	Shells and beans
5	Polyphenols	Shells, leaves, pod, and branches
6	Compost, Pectic enzyme, Activated carbon and Biogas	Pod husk
7	Particle boards	Shells
8	Essential oils	Leaves, chupons, fl owers and pod husk

Palmyrah

Palmyrah (*Borassus flabellifer* Linn.) palm is a very popular palm in India. The tree is blessed trees as each and every part of the tree is of some use to civilized man. The products of Palmyrah *Viz.,* Neera, Toddy, Palm wine, Flour from young shoot, Palmyrah vinegar, Palm toffee, Palm sugar, Sugar candy, Palmyrah Yoghurt and Nungu.

CONCLUSIONS

The plantation crop sector is a major determinant of growth of the agricultural sector in the country. Although the challenges faced by this sector are numerous and not insurmountable. A well reasoned and cohesive application of cutting edge research, institutional support for development and creative policy initiatives can ensure a vibrant plantation crop sector in the country. Product diversification and adoption of quality standard products are increased productivity. A wide range of products will continue to be developed through product and process development for value addition. However, there are many more challenges in further application and dissemination of these new products on domestic and international markets.

Importance of fat in diet

Ravi and Dr. Guneshori Maisnam

BSc. Agriculture (Hons)
Lovely Professional University
**Corresponding Author: mrcricket32@gmail.com*

ABSTRACT

Fish is a high-protein, low-fat food that provides a range of health benefits. White-fleshed fish, contain low fat in comparision with other source of animal protein, and it has been observed that oily fish are high in omega-3 fatty acids. The types of fats are saturated, unsaturated, hydrogenated, polyunsaturated, monounsaturated. Fats are always low in normal diet because of high calories (1g fat contains 9kcal). Because excess of fats can increase the total calories intake in your per day nutrition. Eating of healthy fats is good for body functioning in which higher amount of essential fatty acids must be present and less of cholesterol for every person. IN my study I have experienced that from the two commonly consumed fishes (Tilapia and salmon) tilapia is lean or low fat fish with higher protein.

INTRODUCTION

Dietary fats are essential to give your body energy and to support cell growth. They also help protect your organs and help keep your body warm. Fats help your body absorb some nutrients and produce important hormones, too. Your body definitely needs fat.
Fat is a natural oily substance occurring in animal bodies, especially when deposited as a layer under the skin or around certain organs.Fish is a high-protein, low-fat food that provides a range of health benefits. White-fleshed fish, in particular, is lower in fat than any other source of animal protein, and oily fish are high in omega-3 fatty acids, or the "good" fats. Since the human body can't make significant amounts of these essential nutrients, fish are an important part of the diet. Also, fish are low in the "bad" fats commonly found in red meat, called omega-6 fatty acids.A growing body of evidence indicates that omega-3 fatty acids provide a number of health benefits. They help maintain cardiovascular health by playing a role in the regulation of blood clotting and vessel constriction; are important for prenatal and postnatal neurological development; may reduce tissue inflammation and alleviate the symptoms of rheumatoid arthritis;may play a beneficial role in cardiac arrhythmia (irregular heartbeat), reducing depression and halting mental decline in older people.The omega-3s found in fish (EPA and DHA) appear to provide the greatest health benefits. Fish that are high in omega-3s, low in environmental contaminants and eco-friendly include:wild salmon from Alaska

(fresh, frozen and canned),Arctic char,Atlantic mackerel,sardines,sablefish,anchovies, farmed rainbow trout andalbacore tuna from the U.S. and Canada.

Marine life, or sea life or ocean life, is the plants, animals and other organisms that live in the salt water of the sea or ocean, or the brackish water of coastal estuaries. At a fundamental level, marine life affects the nature of the planet. Marine organisms produce oxygen and sequester carbon. Shorelines are in part shaped and protected by marine life, and some marine organisms even help create new land. The term *marine* comes from the Latin *mare*, meaning sea or oceanMarine invertebrates include sea slugs, sea anemones, starfish, octopuses, clams, sponges, sea worms, crabs, and lobsters. Most of these animals are found close to the shore, but they can be found throughout the ocean. The health benefits of seafood consumption have primarily been associated with protective effects against cardiovascular diseases (CVD). However, intake of seafood has also been associated with improved foetal and infant development, as well as several other diseases and medical conditions. The health promoting effects have chiefly been attributed to the long-chain n-3 polyunsaturated fatty acids (n-3 PUFA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). In addition, the general fatty acid profile is considered favorable. On the other hand, recent and emerging research on seafood proteins and other seafood derived components suggest that these nutritional components contribute to the health effects. In this paper we review the nutritional characteristics and health benefits of marine foods and ingredients, and discuss some current and future trends in marine food production.

TYPES OF FISH USED BY THE FOLLOWING NUMBER OF POPULATION FOR EATING (1) SALMON (2) TILAPIA

NUTRITION FACTS – SALMON AND TILAPIA

ENERGY(KCAL)	183CAL	96CAL
TOTAL CARBOHYDRATES	0G	0G
DIETRY FIBER	0G	0G
SUGAR	-	0G
PROTIEN	19.9G	20.1G
TOTAL FAT	10.9G	1.7g
PUFA	3.9G	0.4G
MUFA	3.9G	0.5G
CHOLESTROL	59MG	50MG
CALCIUM	12MG	10MG
POTASSIUM	362MG	302MG
VITAMIN A	50MG	0MG
VITAMIN C	4MG	0MG

TYPES OF FAT

- SATURATED FAT - These are solid at room temperature and raised blood cholesterol.
- UNSATURATED FAT - These are liquid at room temperature.

• HYDROGENATED FAT - These are basically unsaturated fats which are chemically converted into saturated fats.
• POLYUNSATURATED FAT - It lowers the blood cholesterol.
• MONOUNSATURATED FAT - It has no effect on blood cholesterol

ESSENTIAL FATTY ACIDS

Out of the many fatty acids, only two are essential dietary concerns and one is conditionally essential in the diet. Linoleic acid (Omega 6 Fatty Acid) is a primary essential fatty acid that the body cannot manufacture. Therefore, it has to be obtained from the diet for normal growth and health. Another fatty acid, arachidonic acid, is made in the body from linoleic acid. Arachidonic acid only becomes essentialwhen linoleic acid deficiency exists.Alpha-linolenic acid (Omega 3 Fatty Acid) is the other essential fatty acid. It has severalfunctions, ie, it is important in growth and is the precursor of two other important fatty acids(Eicosapentaenoic Acid or EPA and Docosahexaenoic Acid or DHA). Like protein / amino acids,the body would rather use the essential fatty acids for growth and functional needs instead offuel need

CHOLESTEROL

Cholesterol is a member of a group of fats called sterols. Cholesterol is made by the body and only occurs naturally in foods of animal origin. The highest concentrations are found in liver and egg yolk, and are also high in meats, poultry (especially the skin), whole milk and cheese. Cholesterol has many important functions. It is a component of all cells, precursor of bile acids, precursor of various sex and adrenal hormones, precursor for vitamin D, and an important aid in brain and nervous system tissues. The body needs a constant supply of cholesterol for proper health and performance; however, too much has been linked with a variety of cardiovascular diseases. For promotion of general health, it is recommended to keep cholesterol nutrition intake levels under 250 mg per day.

FUNCTIONS

The Caloric Value of FatFats have had so much "bad press" that many people forget that they are absolutely needed forlife. Among the many functions of fats in the body is that they provide a lot of energy in the formof calories. To understand this, we need a short detour here to talk about calories.Calories are a measure of the heat produced by the utilization of foods in the body. Carbohydrates and proteins produce four Calories of heat per gram. Carbohydrates, proteins, and fats are all composed of hydrogen, oxygen, and carbon, but fats don't have enough oxygen built into their structures to allow for breakdown. Oxygen has to be added into the mix from the oxygen in the blood.This process is called oxidation (ox-e-DAY-shun), and it gives rise to a great deal more calorieheat than is involved in the breakdown of carbohydrates or proteins, which do have sufficientoxygen. The heat value of a gram of fat is equal to the heat value of two and 1/4 gram ofcarbohydrate or protein. This is why we say that fat has 9 Calories per gram while carbohydrateshave only 4 Calories.

Body Fat as Storage of Energy

Body fat provides the most important reservoir of stored energy as adipose tissue. Even in a person who is not overweight, body fat still makes up about 10 percent of their body weight. From a survival standpoint, this is absolutely critical, since in periods of low food availability or during a famine situation, a person must live off his/her stored body fat or perish. The fact that we are all alive today is proof that our ancestors had bodies that were efficient at storing, and later retrieving, the energy in the body fat.

Fat also serve as Transporters

Another very important function of fats is the transportation and use of vitamins A, D, E, K, and for other substances which are fat soluble. Without fat in the diet, those vitamins would not be able to function. This would result in severe problems with eyesight, skin, nail formation, blood clotting, kidney function, bone growth and repair, reproductive functions, and cellular energy. Additionally, some of the fatty acids that make up fats are absolutely necessary for life. They are called essential fatty acids (or EFAs), because they must be eaten. Fats slow stomach digestion and passage of foods through the intestinal path. This important fat function gives the body the necessary time to absorb the essential nutrients in the protein food, which historically has been in shorter supply.

Additional Functions of Fat

Fat, in the form of structural body fat, provides important protection for the vital internal organs. Fat is a fairly poor conductor of heat, body fat in the subcutaneous tissues (under the skin) actsas insulation, and tends to prevent loss of body heat.Fats are required for brain structure.Substances made from fats also provide the covering for nerves, and thereby, allows nerves tocarry the impulses necessary to function.Fat provides the makeup of the walls of cells, the cell membranes, which are required to allowthe passage in and out of essential chemicals.Fats are part of the structure of the skin, which literally holds us together. The skin is oftenoverlooked as being important for existence, but consider what would happen if the skin were to‘come apart' like old fabric. Fats are necessary for the production of hormones to regulate and initiate body activities.Another function of dietary fats is the stimulation of the flow of bile, and the emptying of thegallbladder. Bile is important in the body's elimination of the waste products created by the normal breakdown of red blood cells. If the bile does not leave the gall bladder as it should, gallstones may form.Fat is absolutely necessary for milk production in nursing mothers, and is required duringpregnancy for the proper development of the foetus.Fat is also necessary for the normal body development of children

RECOMMENDATION

The National Research Council recommends that total fat intake stay below 30% of total daily calories and saturated fat intake stay below 10% of total daily calories (assuming you are only eating the recommended total daily calories for your age and body size, and not more). Further recommendations are made on the essential fatty acids, linoleic

and linolenic acids, which recommend 1 - 2% of total daily calories; roughly 3 - 6 grams. Some health professionals estimate that males may require three times this amount because of their hormonal differences. Saturated fats, along with cholesterol, have been implicated in arteriosclerosis, "hardening of the arteries". For this reason, the diet should be decreased in saturated fats (animal) and increased.

DIETARY SOURCES OF FAT

It seems that plant sources of fat tend to be healthier than animal fats. But, remember that most plant sources of proteins are incomplete and low quality, while animal proteins are complete and high quality. A balance must be maintained to minimize saturated fats and high cholesterol sources that occur in meats, but benefit from the complete proteins they contain. As a general rule, here are some of the foods you should avoid or eat infrequently to keep saturated fatty acids and cholesterol intake low: kidneys, liver, egg yolk, custard, fatty animal meats, coconut oil, butter, palm oil, pork sausage, cream cheese, whole milk products, hotdogs and hamburgers. Instead, eat lean meats like fish, egg whites, skim milk products, chicken, a combination of plant proteins that make complete protein sources, and protein formulas. It is especially important for a bodybuilder following a high protein diet to monitor his/her fat intake. This is why pure supplement formulations of proteins/amino acids are beneficial assets to your health and Muscle-building diet. Regarding pure sources of fat (such as oils), intake of polyunsaturated fat should be substituted or food sources high in saturated fats. Some fat sources that are low in saturated fat and cholesterol are: margarine, corn oil, olive oil, peanut oil, cottonseed oil, safflower oil, sunfloweroil and most nuts. Fats to avoid include: butter, cream, mayonnaise, and mayonnaise saladdressings.

CONCLUSION

In general, a good heart healthy diet is low in fat, however, the calories that you do get from fat should be the healthy unsaturated fat from natural plant sources and ideally none from the unhealthy saturated fats. Trans fat specifically have a significant negative impact on your heart health and also should be avoided completely. For achieving fat loss goal we must be very careful with calories intake and the kind of sources through which calories are coming. Healthy fats are good for joints and for better muscle recovery. If you are an athlete you should be more on balanced diet.

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Overview of mixed fertilizers and its usage in farmer's field

S. Easwari [1*]; R. Rajesh; R. Muthuselvi; P. Naveen Kumar; B. Krishnakumare; R.Minithra; R.Suresh; D. Rameshkumar and N. Jagathjothi

**Corresponding Author: easwari1986@gmail.com*

MIXED FERTILIZERS

Mixed fertilizers are one which contains three major plant nutrients namely N, P and K in suitable proportion. It may be made either at home (or) factories by mixing the constituent fertilizer in correct proportion. It is available in market in a particular grade. The fertilizer grade refers to the minimum guarantee of plant nutrients in terms of total N, available P_2O_5 and water soluble K.

Types of mixed fertilizers

(a) Open type

Here kind and quantity of ingredients are known to the farmers. So that the farmers can select mixed fertilizers suitable for a particular crop (or) soil and climatic conditions.

(b) Closed type

Here the kind and quantity of ingredients are not known.

Materials used in mixed fertilizers

(i) Supplier of plant nutrients

The major ingredients of fertilizers, namely, N, P and K are supplied by nitrogenous fertilizers (eg. Ammonium sulphate, urea, ammonium sulphate nitrate, calcium ammonium nitrate etc.), phosphatic fertilizers (eg. single super phosphate, triple super phosphate etc.) and potassic fertilizers (potassium chloride, potassium sulphate etc.).

(ii) Conditioners

Low grade organic materials are added at the rate of about 75 kg per tonne of fertilizer mixture to reduce caking and also keeping them in good drilling condition. These materials are known as conditioners. Generally, paddy hulls, groundnut hulls and tobacco stems are used as conditioners.

(iii) Neutralizer of residual acidity

The basic substances such as dolomite, limestone etc. are added in the fertilizer mixture to neutralize the residual acidity.

(iv) Fillers

Filler is the light weight materials added to a fertilizer mixture of mixed fertilizer. It is added to make up the difference between the weights of the added ingredients required to supply the nutrient in a tonne of given analysis. Soil, sand, wood ash, coal ash etc. are the common fillers used in fertilizer mixture.

Fertilizer mixtures are generally prepared by the following ways :

(a) Home made fertilizer mixture

This type of fertilizer mixture is prepared manually by the cultivators. Without using special equipment, it is desirable to mix the fertilizer ingredient on the day of application (or) a day before to avoid caking. If the fertilizer mixture is used immediately after preparation, there is no need of adding filler, otherwise, filler may be added to check the mixture from caking into hard mass.

(b) Factory made fertilizer mixtures

This type of fertilizer is prepared in fertilizer mixing plants, where machine mixing is advocated. The fertilizer mixing plants have started to manufacture fertilizer mixture in granulated form. The common granulated fertilizer mixture available in the market are IFFCO – 10:26:26, Gramor 45 - 35 - 14 and and Suphala 15 – 15 – 15 etc.

Precautions to be followed while preparing the fertilizer mixture

- Ammonium sulphate, ammonium chloride and other ammoniacal fertilizers and nitrogenous organic manures should not be mixed with lime.
- Urea should not be mixed with super phosphate.
- Calcium cyanamide, basic slag, quicklime, slaked lime should not be mixed with fertilizer containing N in ammoniacal form.
- Super phosphate should not be mixed with lime (or) $CaCO_3$ (or) wood ashes.
- Sodium nitrate (or) potassium nitrate should not be mixed with super phosphate.
- Ammonium sulphate nitrate should not be mixed with super phosphate.
- Nitrochalk should not be mixed with superphosphate (or) lime.

Advantages of mixed fertilizers

- Mixtures usually meet nutrient deficiencies in a more balanced manner.
- Less labour is required to apply mixture than straight fertilizers. This is an important factor where farm labour is scarce and expensive
- When fertilizer mixture is used, there is no need of purchasing straight fertilizers separately and also for application in the soil.
- Micronutrients can also be added with the fertilizer mixtures.
- When fertilizer mixtures are prepared in granular form, it is easily to apply.
- Fertilizer mixture containing suitable filler improves the physical condition of the soil.

Disadvantages of mixed fertilizer

- Fertilizer mixture of a particular grade suitable for a particular crop cannot be applied profitably to all crops
- Use of fertilizer mixtures does not permit application of individual nutrients which may be best suited to meet the needs of a crop at specific times.
- The cost of fertilizer mixture is usually higher than the straight fertilizer. Because labour is required to prepare the fertilizer mixture.

Compatibility of mixed fertilizers

The preparation of satisfactory mixed fertilizers requires a detailed knowledge of the physical and chemical characteristics of the individual materials, their behaviours in mixtures under different conditions of storage, transportation as well as under varying circumstances of atmospheric temperature and humidity. In mixing straight fertilizers, the following general rules should be observed.

1. Fertilizers containing ammonia (e.g. ammonium sulphate, ammonium nitrate) should not be mixed with basically reactive fertilizers (eg. Lime, basic slag, rock phosphate, calcium cyanamide) as losses of N may result through release of NH_3.
2. All water soluble P fertilizers (super phosphate, triple super phosphate and ammonium phosphate) should not be mixed with those fertilizers that contain free lime, because this contains a portion of the soluble phosphate into an insoluble form.
3. Easily soluble and hygroscopic fertilizers like calcium ammonium nitrate, urea and potash salts tend to cake or form lumps after mixing. Such fertilizers should not be mixed shortly before use.
4. Slightly acidic superphosphate may liberate acid from certain fertilizers (e.g. nitrate and chlorides) and this may damage the gunny bags and drilling equipments.

Overview of Organic Farming in India

P. Naveen Kumar[1]*; B. Krishnakumare; R. Minithra; R. Suresh; D. Rameshkumar; N. Jagathjothi; S.Easwari; R. Rajesh and R. Muthuselvi

[1]* *Senior Research Fellow, DABD, TNAU, Cbe-03*

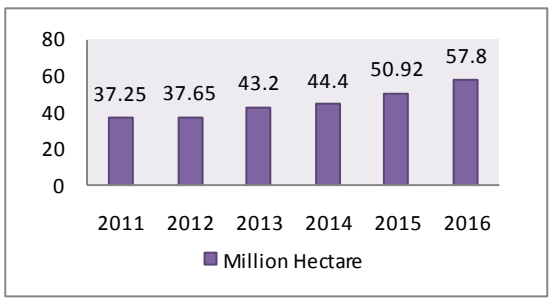
**Corresponding Author: naveen191992@gmail.com*

Organic farming is an approach for sustainable agricultural production without deteriorating soil quality, farm diversity and avoiding hazards to the environment on a long term basis. The principle of organic farming lie in the maintenance of soil fertility through careful husbandry, recycling of agricultural wastes, reduction of external inputs and use of natural forms of pest management and weed control. Use of organically produced seed materials, seed treatment using cow dung, neem cake, farmyard manure incubated with bio-inoculants, green manuring, vermicomposting, panchagavya, jeevamrutham and ash formed the strategies of organic production.

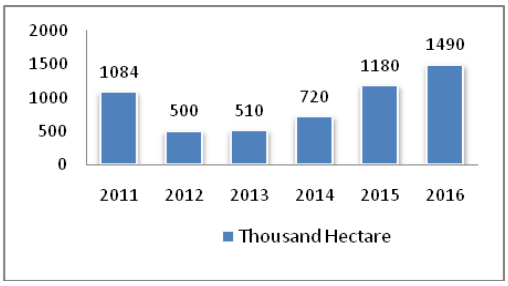
World Scenario of organic Farming in 2016-17

World has about 50.9 million hectares of agricultural land are organic (including conversion areas). About 1.1 percent of the agricultural land is organic. In 11 countries 10 percent or more of the farmland is organic. It was about 2.4 million producers were reported, more than three quarters are in developing countries. Australia (22.69 Million hec) is the largest areas of organic agricultural land 2015. The country with the most producers is India (585200), followed by Ethiopia (203302) and Mexico (200039).

1. Global Organic Agricultural Land (2011-16)

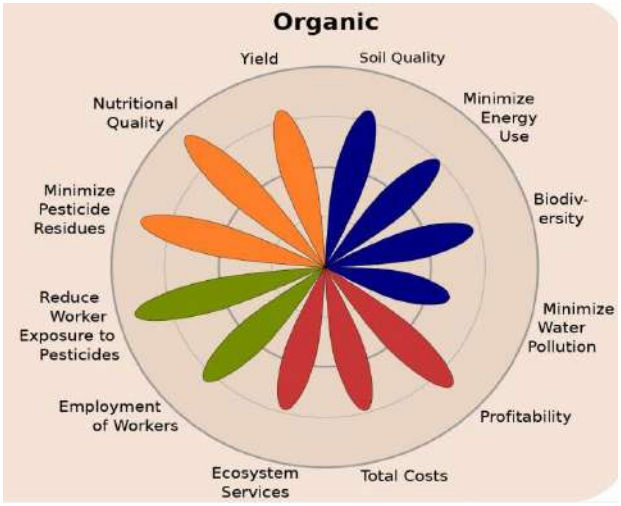


2. Indian Organic Agricultural Land (2011-16)



In Global organic agricultural land, for the year of 2011 it was about 37.25 million hectare increased to 57.8 million hectare in 2016. As well as in Indian Organic Agricultural Land for the year of 2011 it was about 1084 thousand hectare increased to 1490 thousand hectare in 2016. The same trend was arrived in India. (*Source: The World Organic Agriculture: Statistics and Emerging Trends 2018)*

India rank ninth position with the largest organic agricultural land area in 2016. In India, about 5.71 million ha area is under organic cultivation that includes 26 percent cultivable area with 1.49 million hectare and rest 74 percent (4.22 million hectare) forest and wild area for collection of minor forest produces. India produced around 1.35 million MT (2015-16) of certified organic products. Among all the states, Sikkim has covered largest area under organic certification followed by Madhya Pradesh and Rajasthan. Sikkim becomes India's first organic state. The total agricultural area under organic farming in Tamil Nadu during 2016-2017 was 5712.79 ha which accounted for 0.80 per cent of the total area under organic farming in India. The total volume of Organic export during 2015-16 was 263687 MT (APEDA 2016). Oil seeds (50%) lead among the products exported followed by Processed food products (25%), Cereals & Millets (17%), Tea (2%), Pulses (2%), Spices (1%), Dry fruits (1%), and others.



Benefits of Organic Farming

Organic Farming Discourages Environmental Exposure to Pesticides and Chemicals; It Builds Healthy Soil; It Fights with the Effects of Global Warming; It also supports Water Conservation and Water Health. Apart from all the other benefits one of the most important benefits of organic farming is the health benefits of organic foods. People consuming organic foods reduces the risk of risks of physical ailments such as heart attacks, cancer, and even strokes.

CONCLUSION

Organic farming perceptions are quite divergent. But there is a strong consensus on its eco-friendly nature and inherent ability to protect human health. Also, many studies have revealed that organic agriculture is productive and sustainable. The ill effects of the conventional farming system are felt in India in terms of the unsustainablity of agricultural production, environmental degradation, health and sanitation problems, etc. Organic agriculture is gaining momentum as an alternative method to the modern system. Many countries have been able to convert 2-10 per cent of their cultivated areas into organic farming. The demand for organic products is growing fast (at the rate of 20 per cent per annum) in the major developed countries.

Coconut Production and Marketing in Tamil Nadu

Pavithiran S[1], Sharad Sachan[2*],SargikSharma[3] ,Jaskaran Singh[4],Subham Prasad Swain[5]and Harit Mukati[6]

[1,3,4,5&6]B.Sc Student, [2] Assistant Professor,
School of Agriculture, Lovely Professional University, Jalandhar (144411), Punjab (INDIA)

[2]Corresponding Author: sharad.19461@lpu.co.in

ABSTRACT

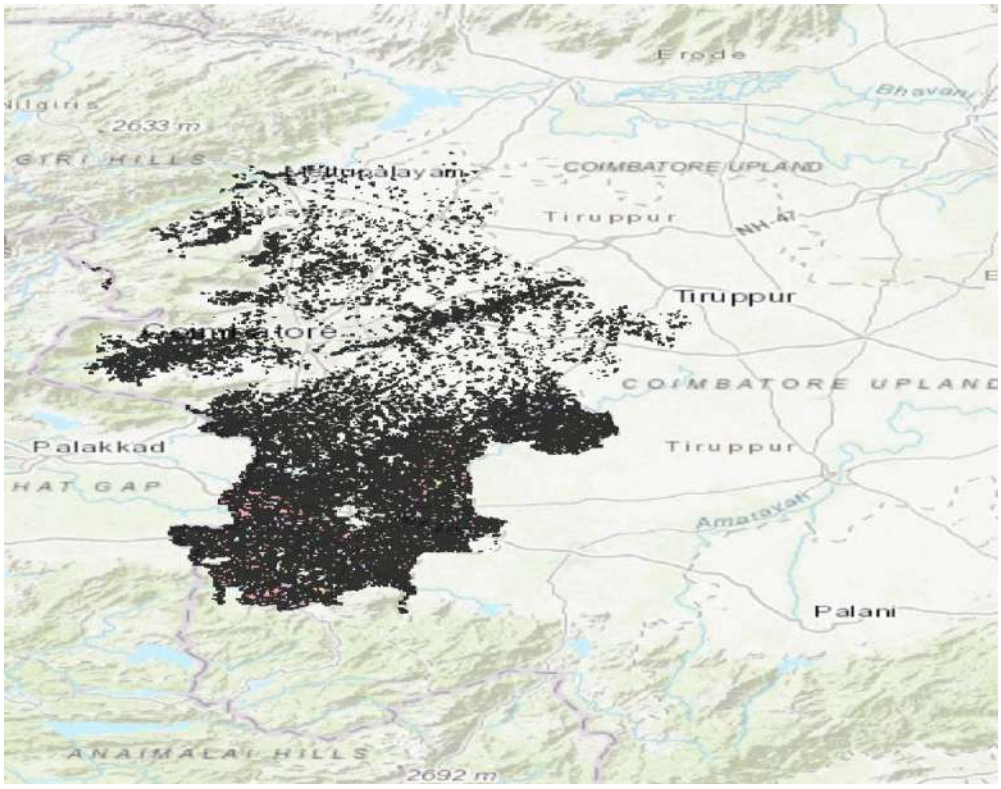
Coconut referred as 'Kalpavriksha' is useful in several ways like dried coconut flesh (copra) used in oil making, coconut water which is a delicious drink etc. It is a plantation crop. Coconut is grown mainly in tropical equatorial condition with the pH range of 5.5 to 8.0 .Mainly grown in south east Asian regions like Indonesia, Philippines , India, Sri Lanka because of its geography of tropical climate surrounded by ocean. In India it is mainly grown in Indian states like Kerala, Tamil Nadu, Andhra Pradesh, Karnataka, Goa, Odisha as they are located near the coastal region and having access to moist winds. In Tamil Nadu, Coimbatore district tops in production and Thiruvarur district tops in productivity. As one third of Indian population is dependent on Indian agriculture directly or indirectly, the processing and marketing of coconut based products gives employment to large population of the country. It contributes both directly and indirectly to the countries GDP growth. For marketing of coconut and its products, government had established the Coconut Development Board(CDB). Coconut marketing has several constraints like intermediaries, transportation problem and farmers suffered by yield loss because of pests and diseases.

INTRODUCTION

The coconut tree (Cocosnucifera) referred as 'Kalpavriksha' because of its uses in one or other way. Coconut is a type of drupe in which the seed or its endosperm is the edible part. It also contains a fibrous part called mesoderm. Both endosperm and mesoderm has its economic importance and various uses. Since ancient times it is used for oil making and it is also used for manufacturing of soaps, hair oil, candies, coir making and other industrial products. The coconut water in the tender nut is a delicious drinks abundant in vitamins, mineral and antioxidants. Coconut tree is a member of palm tree family and it is the only living species of the genus Cocos. In Tamil Nadu, because of its huge production and marketing it has its specificity for the location of agro Industries and contributes largely to the state's and nation's economy.

NATIONAL IMPORTANCE OF COCONUT:

Coconut is grown almost in 93 countries of the world. It is grown especially in South East Asian countries take Indonesia (17.5 m ton), Philippines (14m ton), India (11.5m ton), Sri Lanka .In India it is grown in more than 18.95 lakh ha with an estimated 16943 million nuts as per as per 2010 -11 data . The average productivity in India is 8937 nuts per ha. In India, because of its peninsular geography having access to ocean and tropical climate,it is grown in many states like Kerala, Tamil Nadu, Karnataka , Andhra Pradesh ,Goa ,Odisha, Gujarat, etc.In Tamil Nadu , the leading production comes from Coimbatore followed by Tiruppur and Tanjavur districts and Thiruvarur district tops in productivity . Tamil Nadu is naturally gifted for the cultivation of coconut and its market demand. Percentage increase in 2014-15 production compared to 2013-14 production is 3.90% in Tamil Nadu and 17.98% in Kerala.2014-15 productivity is 11319 nuts/ha in Tamil Nadu and 6042 nuts/ha in Kerala. Below mentioned is the map (Fig. 1) of coconut producing area in Coimbatore district (leading coconut producing district) of Tamil Nadu.



(Fig. 1) Map of coconut growing area in the Coimbatore district.

REQUIREMENT FOR COCONUT PRODUCTION

Temperature	18-43 degree Celsius (27 degree Celsius is optimum)
Rainfall	1000-3000 mm (2000 mm is optimum)
pH	5.2-8.0
Plant population	110-140 palm/ha (117 palm/ha is optimum)
Spacing	7.5 *7.5
Soil	Grown widely in various soils like laterite alluvial red sandy loam soil

	with a fair water holding capacity
Irrigation	Basins of 1.8m radius and 10-20 cm depth is preferred and each palm requires 600-800 liters of water in 6-7 days interval. Drip irrigation is best suited for coconuts with optimal use of water and labor.
Intercultural operation	To provide aeration to soil and to control weeds minimum tillage is sufficient
Green manure and cover crops	To provide organic matter content to the soil and to prevent soil erosion in the coconut field green manure crops like sun hemp are grown
Fertilizers and manure	20-50 kg organic manure per palm during the onset of south west monsoon ever year. 0.34 kg N,0.17 kg P, 0.68 kg K per palm for first 2 years and 0.5 kg N,0.4 kg P, 1.0 kg K per palm from third year onwards
Yield	On an average 127 nuts / palm / year

HARVESTING AND UTILIZATION

Coconuts are harvested at various intervals. In high yielding varieties, bunches grows regularly and harvested once a month. It matures in 12 months after opening of the spathe. The economic life of coconut tree is 60 years. Ripe coconut is the major source of coconut products. 11 months old nuts give fiber of good quality. Green husks are used for the manufacture of coir fiber. Its utilization is mainly in the traditional activities like copra making, oil extraction,coir manufacture and toddy tapping. It is also used for making virgin coconut oil,desiccated coconut, coconut water based vinegar, coconut biscuit, coconut candies, etc.

COCONUT DEVELOPMENT BOARD:

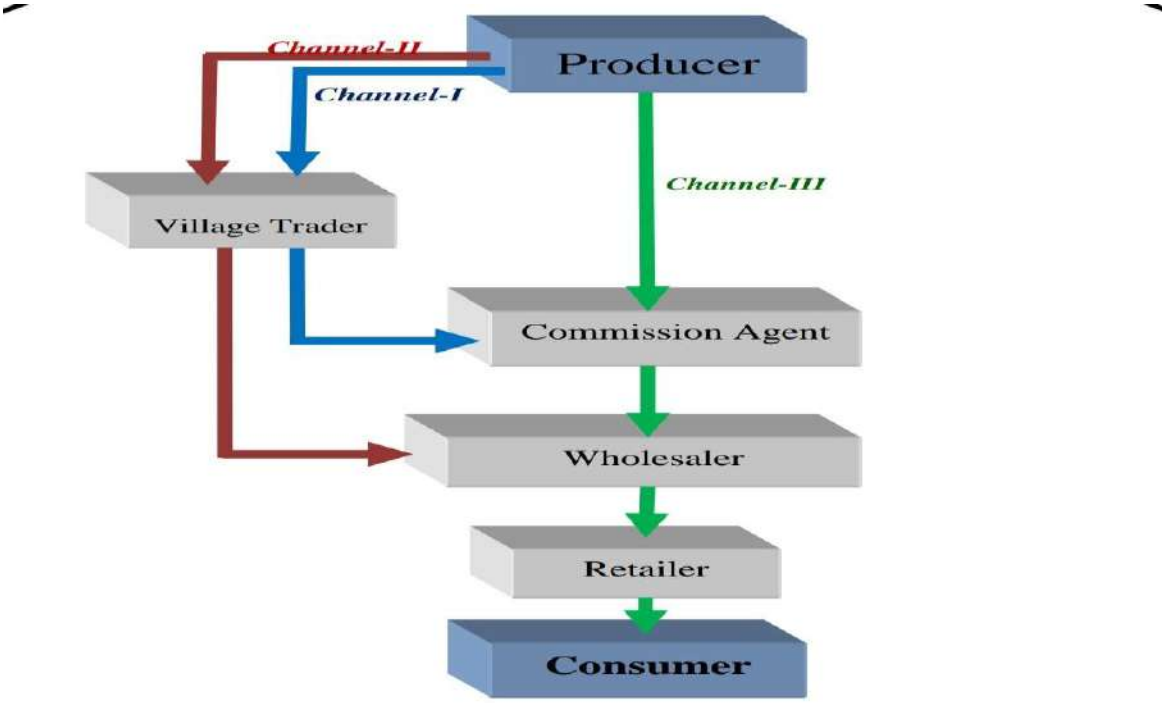
Coconut development board (CDB) came into existence in 1981 under the ministry of agriculture, government of India. Its functions include measures for development of coconut industry, to look after export and import of coconut and its products, to improve marketing of coconut and its products. They also organize developmental programs to the farmers and industrialist. They identify new markets to sell coconut and its products. They implement National Crop Insurance Programme to help coconut growers and to give financial assistance for coconut growers under technology mission. It identifies marketing networks in the coconut growing areas like cooperative marketing federations, NAFED, retail chains, etc.

COCONUT INDUSTRIES IN NADU

1. Nelsun Coir Private Limited, Chennai.
2. Aktchaya Industry, Chennai.
3. Hema Coconut Industry, Tamil Nadu.
4. Nelsun Coir products Private Limited, Thoothukudi .
5. Sakthi Coir Exports, Tamil Nadu.

MARKET CHANNEL

Marketing channel is also known as distribution channel. It is the channel through which goods move from the point of production to the point of consumption. In the marketing of coconut there are 4 important intermediaries. They are wholesalers, retailers, oil Miller and copra maker. Study says that in India maximum number of coconut growers sell their nuts through channel 2, which accounts for about 38 percent. There are 4 important marketing channels through which coconut is sold in Tamil Nadu. They are (Fig. 2)



(Fig. 2) Flowchart on marketing channels of coconut.

1. Channel 1 – producer – copra maker – oil miller – wholesaler – consumer.
2. Channel 2 – producer – oil miller – wholesaler – retailer – consumer.
3. Channel 3 – producer – oil miller – consumer.
4. Channel 4 – producer – itinerant trader – wholesalers – oil millers – retailers – consumption

MARKETTING STRATEGIES:

1. Identification of product basket like coconut chips, coconut candies, coconut milk, virgin coconut oil, desiccated coconut powder, etc.
2. Selection of target markets like urban areas with high population.
3. Assessment of market demand by analyzing the market trend and having proper study.
4. Better supply chain management ensuring the farmers on good returns
5. Efficient resource mobilization and logistics.
6. Collaboration with the cooperative marketing federations.
7. Use of information technology (IT) for e-trading, etc.

MARKETING CONSTRAINTS IN TAMILNADU

The major constraints of coconut growers are

1. One of the major constraints in agriculture marketing is the role of the middlemen between the producer and ultimate consumer .These middlemen's are mostly making higher profits by giving less money to farmers for the produce and selling it for higher price to the consumer. Because of these middlemen's actions the farmers are mostly affected.
2. Lack of exclusive market for coconut is also a major constraint
3. Lack of storage facilities in the farm
4. More uncertainty leading to fluctuation of price of agriculture produce
5. Lack of village level coordination
6. Scarcity of labour for transportation and marketing
7. Monopoly of traders the market
8. Distant location and transportation problem

CONCLUSION

Being a Plantationcrop, coconut contributes fairly to a good extent to the agrarian economy. Coconut cultivation gives profit to the farmers but is not enough for them so government should provide technical and financial assistance to the farmer .Usually the large farmers sells their produce by giving it as contract for 1 year term in Tamil Nadu. In Tamil Nadu , the small and marginal farmers usually grows coconut tree as subsistence farming which is good thinking to meet their family needs and the excess is sold in markets. Because of its wide usage and increasing market demand there is a good scope for farmers to grow coconut as well as government should encourage those farmers by conducting welfare programs and educating them about modern technological practices.

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Drought stress and its mitigation strategies in fruit crops

Khalasi* D. N.; Tandel Y. N. and Ahlawat T. R.

ASPEE College of Horticulture and Forestry
Navsari Agricultural University, Navsari-396 450, Gujarat.

**Corresponding Author: khalasidevang64@gmail.com*

Abstract

In today's climatic change scenario, crops are exposed more frequently to episode of abiotic stresses. In this conditions plants are impaired in expressing their genetic potential for growth, development and production. Common abiotic stress in plants include light, salt, flood, high temperature, low temperature and drought. Among the various abiotic stress factors drought limit the crop production by restrict water supply resulting reducing tissue water content, stomatal conductance, metabolic growth and production. Drought is a predominant cause of low yield worldwide. Severe droughts occur periodically in several major food producing countries, having far-reaching impact on global food production and supply. Major impact of drought stress in some fruit crops has been summarized in the discussion. When strawberry plants are severely water-stressed from the beginning of the growing season, total fruit production can be decreased by about 80%. Water deficit in the early stage of mango fruit development lead to increase fruit drop. Calcium uptake by roots requires adequate moisture, this nutrient is often deficient during dry seasons, resulting in fruit disorders such as corkspot and bitterpit in apple.Mild water stress imposed may leads to reduction in vine vigor in grape. Drought stress could be mitigated by adopting approaches like mulching, drip irrigation, water conservation techniques, use of mycorrhiza, use of antitranspirants, use of resistant and tolerant varieties and use of hydrogel *etc*.

Keywords: Abiotic stress, Drought, Fruit crops, Water conservation and Mulching

INTRODUCTION

Drought can be defined as an extended period of deficit rainfall and is the most serious threat to world food security. It is considered the mainly popular environmental aspect limiting plant growth and crop productivity. At the same time climate change is increasing the occurrence of severe drought conditions in different area all over the world particularly in arid and semiarid regions, in term of its severity and average of drought in the coming.Total geographical area of the country is 329 million hectares. Out of this, 195 million hectares is gross cropped area and 141 million hectares(42.86 %) is net sown area. Barren land, degraded land and waste land area in the country is 41

million hectares, 63.85 million hectares and 128 million hectares, respectively. The total area cover by arid zone in country is 39.54 million ha. North-West India constitutes almost 90% of the total arid zone in the country.

Drought stress causes different negative effects on plant growth and total yield by decreasing leaves absorption of photosynthetic active radiation, reduced radiation-use efficiency and minimized harvest index. Drought severity is changeable as it depends on numerous factors like soil structure and it is water reserve capacity, average of rainfall, and evapo-transpiration rate. To minimize the negative effect of water stress, plants have various signaling pathways and respond by changing their growth pattern, up-regulation of antioxidants, accumulation of compatible solutes and by producing stress protein (Anjali *et al*., 2017). Plants acclimatize with drought stress using various strategies which include drought escape, drought avoidance and drought tolerance. Keeping in mind challenges of drought and demand for good quality fruits in stress prone areas, the present need before researchers and growers is to overcome the challenges posed by drought. There are multiple approaches like mulching, drip irrigation, water conservation, use of growth retardants, proper nutrient management, use of antitranspirants and drought tolerant rootstock through which we can manage the challenges posed by drought.

In general, to grow crops successfully in the future, growers will need to adapt to less available water and to take better advantage of the positive effects of drought. Fortunately, there are positive effects associated with drought. Drought stimulates the secondary metabolism, thereby potentially increasing plant defences and the concentrations of compounds involved in plant quality, particularly taste and health benefits. The role of drought on the production of secondary metabolites is of paramount importance for fruit crops. However, to manage crops effectively under conditions of limited water supply, for example by applying deficit irrigation, growers must consider not only the impact of drought on productivity but also on how plants manage the primary and secondary metabolisms. This question is obviously complex because during water deficit, trade-offs among productivity, defence and quality depend upon the intensity, duration, and repetition of events of water deficit. The stage of plant development during the period of water deficit is also crucial, as are the effects of other stressors. In addition, growers must rely on relevant indicators of water status*i.e.* parameters involved in the relevant metabolic processes, including those affecting quality.

EFFECT OF DROUGHT STRESS

- Decrease in germination rate
- Reduction in photosynthesis and chlorophyll contains
- Stomatal closure
- Reduction in shoot mass
- Reduction in number of leaves
- Reduction in flowering
- Decrease in seed weight, seed count and seed composition

- Reduction in root growth and development
- Decrease in nutrient and water uptake
- Decrease in yield

Responses of drought stress

- Decrease in leaf expansion
- Increase in ROS scavenging species (SOD, CAT, APX and GR)
- Production of phytohormones (ABA)
- Cell accumulates sugars, amino acids, alkaloids, polyols
- Inorganic ions for osmotic adjustment

This maintain photosynthesis and drought stress related process and finally improve yield

Type of drought

1) Agricultural drought : It is the situation in which the water available to the plants through rainfall and irrigation is insufficient to meet the transpiration needs of the crop.
2) Socioeconomic drought : This type of drought occur when the demands for an economic goods exceeds the supply as a result of weather related shortfall in water supply.
3) Meteorological drought : It is qualified by any significant deficit of precipitation.
4) Hydrological drought : It is manifest in noticeably reduce river and stream flow and critically low ground water table.

a) Various morphological mechanisms performedby plants for survival

b) **Drought escape :** It is the ability of plants to adjust their growth periods or lifecycle to avoid the seasonal drought stress.

c) **Drought avoidance :** Drought avoidance consist of mechanisms that reduce water loss from plants, due to stomatal control of transpiration and also maintain water uptake through an extensive and prolific root system is helpful for extracting water from considerable depth.

d) **Drought tolerance :** The ability of cell to continue its metabolic function at low water potential.

Classification offruit crops on the basis of drought tolerance

Tolerant	Moderately tolerant	Sensitive
Ber	Avocado	Citrus
Phalsa	Passion fruit	Papaya
Custard apple	Litchi	Banana
Date palm	Longan	Sapota
Pomegranate	Carambola	Rambutan
Aonla and Fig	Mango, Cherry, Jack fruit and Guava	Apple

Drought tolerance in fruit plants are characterized by the following features

Special features	Fruit crops
Reduction in number and size of leaves	Aonla, Karonda and Wood

	apple
Leaves densely pubescence	Phalsa and Fig
Leaf tip modified into spines	Date palm and Ber
Leaves has shinning surface due to presence of thicker cuticle	Sapota and Pomegranate
Deep and extensive root system	Mango and Ber
Radiation reflected by the glittering leaves/ waxy coating	Ber, Bael, Wood apple and Fig
High degree of phenol and tannin content	Mango and Karonda

Impact of drought on fruit crops

Crop	Effects
Mango	Water deficit in the early stage of fruit development lead to increase fruit drop
Grapes	Mild water stress imposed may leads to reduction in vine vigor
Strawberry	When strawberry plants are severely restrict water stressed from the beginning of the growing seasons, total fruit production can be decrease by about 80%. stress after harvest runner production is delayed during current seasons and result yield loss in following year
Apple	Early season water stress restrict fruit cell division contributing to small fruit during current season and reduce starch accumulation, which shortens the storage life of fruit after harvest. The uptake of nutrient is often deficit during dry condition, resulting in fruit disorders such as corkspot and bitterpit
Peaches	Drought stress reduces flower bud development of and can lead to fruit defects.

The effects of drought range from morphological to molecular levels and are evident at all phenological stages of plant growth at whatever stage the water deficit takes place. Drought restricts water supply which results in a reduction of tissue water content, stomatal conductance, metabolic processes and growth. Numerous studies have shown that plant roots can sense changes in soil water content. As soils become dry, root-sourced signals are transported via the xylem to leaves and result in reduced water loss and decreased leaf growth.

MITIGATION STRATEGIES

[1] Nutritional management: Potassium and magnesium during conditions of water deficit enhances the water uptake as well as the water relations in the plant tissues by osmo regulations process.

[2] Irrigation practices like drip irrigation, partial root zone drying and buried diffuser

a) **Drip irrigation :** water is directly given to the root zone as a drop by drop so high application efficiency and distribution uniformity.

b) **Partial root zone drying(PRD) :** Arid and semi arid area increasing of irrigation efficiency is considered as very important in order to prevent drought stress and maintain plant productivity. In this area, novel irrigation water saving techniques, which involve deliberate wetting and drying of specific site of root zone so that the production of specific root source signals will be optimize including partial closing of stomata and their by increasing irrigation use efficiency.

c) **Buried diffuser :** Considering the problems of water in the Arab countries, and in arid and semi arid region in the world, Dr. Chahbani Bellachheb (Senior Teacher Researcher in Arid Region Institute in Tunisia) has invented a new technique for irrigation called buried diffuser. A Tunisian industry and commercial company(Chahtec SA) is created to manufacture and to distribute worldwide the different types of diffuser. The diffuser has a specific part composed of porous material allowing a rapid infiltration of the irrigation water. This porous material does not retain the water in the pores or on the surface of the material(Fig. 1).

Fig. : 1 Installation of buried diffuser

[3] Soil moisture conservation : It is done by following different ways.

a) **Mulching :** Covering top of the soil with loose extraneous matter is known as mulching. It is of two types : organic and inorganic. The grass clippings, crop stump, straw, bark chips, compost, manure, saw dust, cotton burs, wooden pieces, rice husk, bran, onion and garlic scales, leaf litter, cinders, paper, latex etc. are some important organic mulches, whereas, plastic film, metal foil, sand, gravel, stone etc. constitute inorganic mulches. It prevents evaporation of moisture from the surface.

b) **Organic matter :** The oil organic matter is of fundamental importance in maintaining soil fertility and soil water regimes. Organic matter has ability to absorb and hold up to 90% of its weight in water. Mostly water hold by the organic matter causes aggregation, which improves soil structure. Better soil structure improve permeability to air and water, which in turn improve soil ability to take up and hold water.

c) **Conservation tillage:** Tillage break the continuity of pores, thus has an impact on evaporation and infiltration rate. The reduced tillage soil is less disturbed, so the moisture loss and soil compaction that follows tillage is avoided. This increase the infiltration and percolation of water through the soil, leading to better root

development and crop growth. Minimum disturbance of soil in turn improve the living condition of beneficial organisms enhance their activity significantly. Micro organisms secrete various enzymes, hormones, vitamins and organic acids that cause aggregation of soil particles, thus improve soil structure.

d) **Rainwater harvesting :** Rain water harvesting has been assigned high priority in the rainfed areas through integrated water management programmes to promote intensified agriculture and also to safeguard against risks of frequent drought, encountered in the arid and semiarid regions. Rain water harvesting is the process of collecting, concentrating and improving the productive use of rainwater and reducing unproductive depletion. In other words, it involve collection, storage and recycling of rainwater for agricultural, domestic or industrial purpose. Rain water harvesting help in recharging groundwater. The harvested water should not be used for irrigation through flooding, instead high-tech irrigationsystems such as micro sprinkler or drip irrigation should be practiced.

e) **Recycling of organic residues :** Incorporation of organic residues such as farm yard manure, compost, green manure, waste plant residues improve organic matter status of soil, which in turn enhance soil water retention(Kumar and Bhople, 2017).

[4] Selection of fruit crops and varieties : The crop selected should possess drought tolerant mechanism likedeeproot system(ber), leaf shedding(ber and gonad), water binding mechanism(fig), presence of thorn(karonda), leaf orientation(aonla) and well formed canopy(kinnow). Varieties for drought condition should be short in duration. Some of drought tolerant varieties in fruit crops viz., Pomegranate-Ruby, Custard apple- Arka Sahan, Fig- Deanna and Excel, Banana – Karpuravali and Aonla-Goma Aishwariya.

[5]Application of PGR :

- Exogenous application of jasmonic acid induced drought tolerant by increasing the betaine level in pear. Jasmonic acid cross talk with other hormones to enhanced survival of plant under drought. It improves drought tolerance by various mean including root development, scavenging of reactive oxygen species (ROS) and stomatal closure.
- Cycocel and mepiquat chloride : For promoting root growth (for more water absorption) and suppressing leaf area of water and delaying on set of leaf senescence.
- Cytokinin : The rise in cytokinin level under drought in xylem sap stimulates stomatal opening by declining its sensitivity to ABA.
- Ascorbic acid : It act as a n antioxidant agent for ROS accumulating under stress and thus avoiding membrane damage.
- Brassinolids : These PGR increase the photosynthesis activity of the plants.

[6] Mycorrhizal association : It is a symbiotic association between green plant and fungus. The plant make organic molecules such as sugar by photosynthesis and supplies

to the fungus. The fungus supplies to the plant water and mineral nutrient such as phosphorous taken from soil. The use of arbuscular mycorrhizal(AM) fungi along with recommended package of practices enhanced the water use efficiency of crop significantly. The AM fungi has ability to expand surface area of plant root system by 10 to 1000 folds into the soil through their ramifying hyphae, thereby increasing their exploratory area for harnessing water from deeper layers, there by establishing its vital role in water management. The AM fungi inoculation resulted in improvement in soil structure by way of binding of soil aggregates, involving their hyphal network and enhancing soil moisture retention capacity(Staddon *et al*., 2013). AM fungus induced drought tolerant in citrus species. Genera such as *Acaulospora, Gigaspora* and *Glomus* were dominantly observed in the citrus rhizosphere.

[7] Use of rootstocks : The use of drought tolerant rootstock would minimize the immediate of dry condition and enable variety to recover quickly by transferring their survival strategy to the grafted shoot scion.

Drought tolerant rootstock in fruit crops

Sr. No.	Fruit crop	Drought tolerant rootstock
1	Citrus	Rangpur lime
2	Ber	*Zizyphus rotundifolia*
3	Apple	MM111 and MM104
4	Grape	Dogridge
5	Cherry	Mahaleb

Greater osmotic adjustment maintain water relations under osmotic stress. It involve accumulation of soluble solute like sugar, proline, organic acid etc. It allows the cell to decrease osmotic potential and as a consequence increase the gradient for water influx and maintain turgor pressure so keeps growth is observed. Sunki Maravilha rootstock as compared with Rangpur lime, exhibited higher ABA and greater number of differentially expressed protein in response to drought. This protein involve with DNA repair and processing. Higher level of SA and carbohydrates such as trehalose and raffinose that help to prevent cell damage caused by drought and maintain cell metabolism and turgor lead to rootstock survival (Santana-Vieira *et al*., 2016).

[8] Use of anti-transpirants : Antitranspirant are compound applied on the leaves of plants to reduce transpiration. It is used to preserve and protect plants from drying out too quickly. They have also been used to protect leaves from salt burn and fungal disease. Nearly 99 % of the water absorbed by the plant is lost in transpiration.

Classification of antitranspirants

- Stomata closing : They reduce water loss through closing stomata. e.g. PMA(Phenyl mercuric acetate)
- Film forming : Check transpiration loss due to formation of thin film which act as physical barrier. e.g. Oil, Waxes, Mobileaf *etc*.
- Reflecting type : These chemicals reflect the radiation and reduce leaf temperature. e.g. Kaolin

- Growth retardant : These chemicals reduce shoot growth and increase root growth and thus enable the plant to resist drought. e.g. Cycocel

[9] Use of hydrogel: Hydrogel are croos linked polymers with a hydrophilic group which have capacity to absorb large quantities of water without dissolving in water. Hydrogel are used to improve the ability of soil to absorb water. They are prepared by grafting and cross linking of water absorbant polymers(polyacrylamide) onto a cellulose derivative backbone polymer chain. These hydrogel are more biodegradable and therefore safer to the environment and play a vital role in stress alleviation at appropriate time as needed by the plants

Agricultural hydrogel products available in India

Trade name	Manufacturing company
Pusa hydrogel	IARI, New Delhi
Waterlock 93N	Acuro Organics Ltd., New Delhi
Agro-forestry water absorbent polymer	Technocare Products, Ahmedabad
Super absorbant polymer	Gel Frost Packs kalyani Enterprises, Chennai
Hydrogel	Chemtex Speciality Ltd, Mumbai
Rain drops	M5 Exotic Lifestyle Concepts, Chennai

Research evidence suggest that when the soil is treated with hydrogel, the water volumetric content of soil increase significantly and as the soil dries, the store water is released back slowly into soil. It work like sub-miniature reservoir to retain and supply moisture to crops ever time as the soil underwent altered wetting and drying periods.

[10]Using precision farming to identify crop stress: Precision farming technique have made it possible to assess cope stress, yield estimation and vegetation cover. Hyperspectral image can be taken by camera mounted on drone or aircrafts. Reflected light is analyzed. Health of each crop can be estimated based on the relationship and interaction between foliage and electromagnetic radiation. Helpful in early detection of drought stress resulting from water insufficiency. Farmer can identify specific area to irrigate before drought stress hits the crops.

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Sericulture in India

Somansh Prakash, Uzma Manzoor and HS Gaur

School of Agricultural Sciences
Sharda University, Greater Noida

**Corresponding Author: uzmamanzoor52@gmail.com*

Sericulture is one of the most important agro based industry that includes raising of silkworms for the production of raw silk, which is the yarn acquired out of cocoons spun by some species of insects. There are mainly five varieties of Silk (Mulberry, Eri, Tasar, Muga and Oak Tasar) produced in the world which is obtained from different species of silkworms that feeds on various number of food plants. India is the second largest producer of silk in the world with a production of approximately 30 thousand metric tonnes of silk every year. India is the only country in the world to produce all the five kinds of silk. Among all the silk produced in the country, Muga accounts for nearly 80% of it. Jharkhand, West Bengal, Manipur, Andhra Pradesh, Meghalaya, Assam, Karnataka, Maharashtra, Tamil Nadu and Nagaland are the top ten largest silk producing states of India.

India earns a foreign exchange of about 400 crore rupees every year by exporting silk and silk products and provides employment to over 8.5 million people. This also contributes a good share to Country's economy. U.S., China and UAE are among the three largest country to import silk from India.

Sericulture is a labour intended, agrarian, small scale business which is suitable for both small and marginal land holders because of its high profit, short maturation period and it develops opportunity for women employment (Parimala, 2009).About 400 years ago, Sericulture was introduced in Indiaand the industry developed as an agro-industry till 1857, with a production of 2 million pounds of silk yearly (Mohanty, 1998). Silk is the most elegant textile in the world with exceptional grandeur, natural sheen, and inherent affinity for dyes, high absorbing capacity, light weight, soft touch and high longevity, This is known as the "Queen of Textiles" all over the world(Soi, 2019).

Many policy initiatives have been taken by government to encourage Sericulture. These include covering Sericulture under Rashtriya Krishi Vikas Yojna as Agriculture associated activity. This will help sericulturists to avail benefit upto the process of reeling; the Central Silk board Act, Rules and Regulations have been formed by the government of India to conduct quality standards in Silkworm Seed production; the forest Conservation act has been revised in which non-mulberry sericulture will be treated as forest based activity that will enable farmers to rear Vanya Silkworms on their natural host in the forest and The Director General of Antidumping and Allied Duties, New Delhi has proposed introduction of anti-dumping duty on Chinese Silk of 3A grade. A U.S. dollar 1.85 per kg will be charged on imported raw silk of lower grade.

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Sustainable Agriculture: Need of the hour

Jasjit Kaur

College of Agriculture, Punjab Agricultural University, Ludhiana, Punjab, India.

**Corresponding Author: jasjitmander09@icloud.com*

Agriculture,being the dominant occupation, source of livelihood and a major addition to country's gross domestic product (GDP), should, in every possible, manner be developed so as to benefit not only the farmers, people but the nature too. The 1960 Green Revolution delivered about, by using higher quality seeds,higher strategies of irrigation and liberal use of fertilizers, pesticides and insecticides, a grain surplus India. But the cutting-edge reality is way too exclusive than what used to be in the 60s.It has turned out as a widely acknowledged fact that theimmoderate use of chemical substances and endless exhaustion of land fertility is causing a huge depletion in the expected agricultural produce. The modernized and superior "Seed and Fertilizers package" techniques might not hold the sustaining agriculture for prolonged time. The world requires practices which are ecologically just, economically viable and are primarily based on holistic scientific approach. In short, it is a call to adopt Sustainable Agriculture.

What is sustainable agriculture?

Sustainable agriculture is described as the profitable management of natural assets and wise use of technology for the purpose of agriculture to fulfilthe changing human needs, whether food or textiles, along with not solely conservation but also enhancement of quality of environment.

Objectives of sustainable agriculture

It aims to increase farm productivity, maximize social benefit with simultaneous minimization of chemical use and water wastage, prevention of soil erosion and mitigating other evil impacts of modern agricultural practices on the environmental health. It also promotes safety and preservation of indigenous biodiversity to keep the ecological balance. The critical intention is to meet the current wants and to be in position to meet those bobbing up in the coming future.

Failures of modern day techniques:

Tillage system

Tilling has traditionally been used as an approach to prepare a field for planting, controlling weeds, removing plant residue and loosening compacted surface soil. While it is fundamental for successful agro-ecological enterprise ,excess of it has led to soil erosion,related air and water pollution, subsurface soil compaction and low water retentivity. Also, lot of money is spent on gasoline and machinery.

Pressure on groundwater

Intensive irrigation has been most crucial element of the Green Revolution ,however, now has put stress on groundwater resources. In addition, irrigation without proper consideration of drainage leads to water logging and salinization and both of them together ruin the land fertility, inflicting its desertification. As of today, almost 60% of Indian land suffers from water logging and salinization.

Unregulated use of fertilizers and pesticides

It has been estimated that ,considering 1960, fertilizers consumption in northern states of India, especially Punjab, increased thirty folds causing an unprecedented alterations in the pH of soil making it unfit for cultivation. The principle culprit NPK made the soil poor in different micronutrients likes zinc, iron copper, magnesium and so forth. Likewise immoderate pesticides application to kill the pests and guard the plants suffered serious backlash and instead made the pests more resistant over the course of time.

Depletion of organic matter

Good soil is made up of 7 to 10% of organic matter but the unfortunate practices like excessive tilling, burning of field postharvest bring about massive destruction of organic matter and plant residue which holds the soil particles together and hence the land becomes greater susceptible to soil erosion. Decrease in natural fertility and nutrient content of soil are some of its other ill effects. 30% of Indian soil is drought prone due to this reason and about 25-30 hectares of fragile land are progressively degrading.

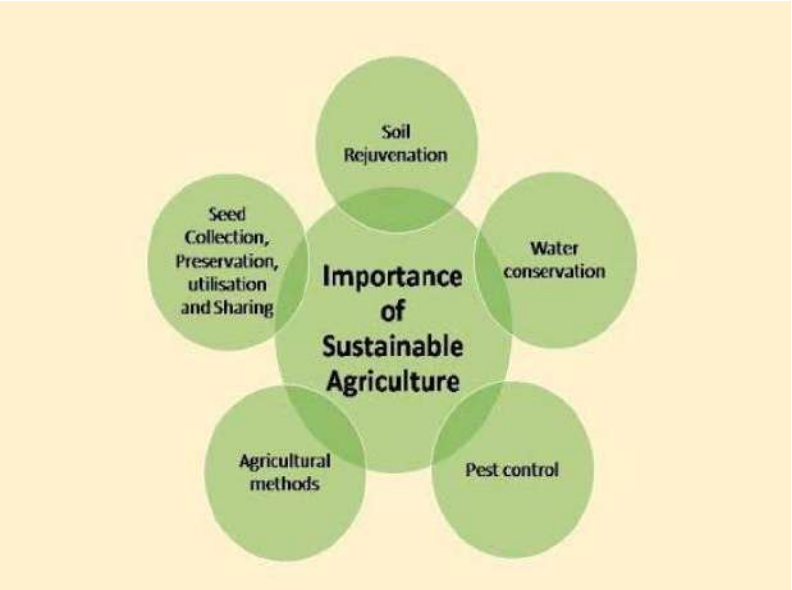
Monoculture is the new trend

Introduction of monoculture replaced the mixtures and rotations of diverse crops like wheat, maize, millets, pulses and oilseeds. Reduction in leguminous crops deprives the soil of natural fertilizing agents. Repeated cropping of wheat and rice lead to draining of the soil off nutrients, eventually converting it into wasteland. There were thousands of varieties of grains and vegetables before the advent of modern agriculture. For an instance, there were about 30,000 strains of rice (Oryzasativa) of which only 10 are known to be cultivated today. This has led to reduction of genetic diversity, when genetic diversity is reduced we have genetically similar flora which is most prone to disease, insects and pests etc.

Farmer's plight

Desertification of land, needless boom of weed need to buy more and more fertilizers and chemicals, alarming expand in the expenditure on machinery and fuel and fluctuating

earnings due to inconsistent yield through harvested crops further adds to the miseries of the farmers.



(Source: ecomwel.org)

Sustainability enhancing techniques and their advantages

Conservative tilling method

For economic and ecological gain, this method aims to reduce the frequency or intensity of tillage activity. It leaves at least 30% of plant residue to cover the soil surface which prevent soil erosion due to water or wind or run off preserves nutrients and increase water holding capacity, unlike standard tilling. Increased moisture also increases the quality of organic matter.Less tilling implies less soil compaction and carbon dioxide can be readily absorbed by the soil, decreasing greenhouse effect too.

Effective cropping methods

In order to cultivate the soil and increase crop yield at the same time it is essential to abandon the insipid crop patterns used today. As alternatives, mixed cropping, intercropping, crop rotation, permaculture etc should be preferred.

Mixed cultivation of two or more crops together protects damage due to pests (as pest are crops specific) and monetary losses against complete crop failure under adversity.

Intercropping, i.e, growing more than one crop simultaneously in the same field in rows following definite pattern(1:1,1:2)preserves soil fertility, improves productivity and saves space and time to plant two or more crops.

Crop rotation is a boon without any disguise in order to overcome the current agricultural crisis. Green manure crops and legumes are primarily used as rotation crops. A possible alternative to wheat and rice crop pattern could be maize-potato-sunflowers. These crop systems require less water, lower inputs but have higher commodity prices.

Permaculture, a popular theme of today, has been practiced since time immemorial. It is intended to operate in harmony with the natural structure, place and properties of the region. Smart field design ensures optimum use of natural resources like use of local water sources for irrigation, ensuring adequate drainage to avoid logging and salinization of water etc.

All these methods not only favour the farmers but also the environment at large, and also helps to tackle the global food crisis.

Smart irrigation

Smart water management is no longer simply about how water is delivered but also when, how often and how much. Employing strategies like drip irrigation, sprinkler irrigation, check basin irrigation and more, if properly installed can save up to 80% more water than the conventional methods. But where flood irrigation is a necessity, irrigation timing should be given proper consideration. Flood irrigation at night suffers minimum water loss due to evaporation and also lets in water to seep down into the soil to replenish the water table. Thus, a smart irrigation layout not only helps in water conservation but additionally helps in increasing the crop yield.

Organic farming

Organic farming is the most talked of topic nowadays but least used and utilised in reality. When it comes to sustainability going natural is the successful approach. The idea of the usage of manure, dung compost,biofertilizers brings about soil nutrient enrichment, maximizes the ecological benefits and reduces environmental hazards. These are cheap and least expensive and can be used even by the poor farmers. Use of bioherbicides,biopesticides and bioinsecticides can in noway deteriorate the soil. Like the vast increase of cacti in India and Australia was once checked with the introduction of its natural herbivore-Cochnealinsect, to control variety of pestsbacillus thuringiensis was used successfully andefficiently. Further methods like these can be employed to protect the crops against pests and provide nourishment to the crop rather than opting for chemical fertilizers and pesticides.

Biotechnology

Use of biotechnology helps to generate vegetation which are highly tolerant to disease, weed, drought etc, for e.g.bt cotton. Use of natural methods along with the aid of some

intelligent technology will increase 15 to 35% additional yield in most vegetable plants.The transgenic plants are richer in nutritional content too. The better quality transgenic wheat contains more proteins and higher lysine content.

(Source:liverur.eu)

CONCLUSION

It is need of the hour to come to our senses and build and promote an agricultural system that benefits the mankind as whole, not only economically but also ecologically. The only solution to all these problems whether economical or ecological faced by the farmers and people worldwide is adoption of Sustainable agriculture by one and all.

"We abuse land because we regard it as a commodity belonging to us. When we see land as a commodity to which we belong, we may begin to use it with love and respect." ***– Aldo Leopold.***

Solar Water Pumps as Sustainable Energy Source in Indian Agriculture

S.Moghana Lavanya* and K.Mahendran

Department of Agricultural and Rural Management,
Tamil Nadu Agricultural University, Coimbatore, India

**Corresponding Author smoghana@tnau.ac.in*

India accounts for about 140 million ha of net sown area and 195 million ha of gross cropped area with total geographical area of 329 million ha. The cropping intensity of India was 139.28 Per cent (2018). India has around four percent of fresh water level of world, out of that 80 percent of water is utilised for agriculture. The major source of irrigation for agriculture includes canals from rivers, groundwater, water storage tanks, etc. Irrigation through ground water was found to be more than 50 per centof total irrigated area (42 million ha), Irrigation through canals accountedfor 22 million ha and remaining area was dependent on monsoon. The net irrigated area in India was estimated to be 68.2 million ha. Rain fed agriculture was predominantly in India with 54 percent of net sown area depending on rain and plays an important role in Indian economy (Dhawan, 2017).

Ensuring effective irrigation for agriculture is necessary as it will have an impact on agricultural productivity and food security of the nation.In order to raise productivity and to cater to the needs of ever-growing population and enhance the profitability and competitiveness of farmers, focus should be made onoptimizing the energy usage and efficient use of available water resources. Pumping systems play a crucial role in provision of optimized solutions for energy and water use. Many studies have pointed out that energy foroperating irrigation pumps is the highest cost driver in the farming system. Usage of best energy management practices will result in cost reduction and optimize the energy use.

Pumpingsystems can be operated using both renewable and non-renewable energy sources. Pumping water from ground level using conventionally powered pumps namely diesel and electricity pumps use resources like fossil fuels or electricity are widely used. In India around 190 lakhs of Electric pumps and 70 lakhs of diesel pumps are used for pumping water from the ground level (KPMG, 2014). In India, more than 40,000 lakhs litres of diesel is consumed and constitutes 3.1 per cent of national diesel consumption and 85 million tons of coal is used for lifting water for irrigation. Many states in India are providing free electricity to farming community for pumping the

water from ground level. Due to frequent power cut and rising cost of fuel to run the diesel pumps, the farmers are moving towards alternate source of renewable energy for agriculture purpose.

The use of renewable energy sources such as wind machines and solar energy were found to be the best alternatives for pumping ground water.Among these harnessing the potential of solar energy had gained importance in recent times.In this, Photovoltaic converts the sun's energy into electricity through electromagnetic means when the PV module is exposed to sunlight.Replacement of one million diesel water pumps with solar water pumps would result in reduction of diesel usage by 94000 lakhs litres over life cycle of SWPs which will result in saving of Rs.8400 crores and reduction of CO_2 emission by 25.3 million tonnes(KPMG, 2014).Government of India had set targets to expand utilisation of renewable energy for generating electricity in our country. About $ 10000 million was invested in promoting the solar sector energy in India in the year 2017. Solar energy production from solar photovoltaic system was observed to be 30.98 billion units during April 2018 to January 2019. Total solar power capacity installation in India was 26.03 GW in 2019 and it was expected to reach 100 GW by 2022.

Government of India initiated Jawaharlal Nehru National Solar Mission in January 2010(Sambodhi, 2018).In 2014, as part of the mission, Ministry of New and Renewable Energy (MNRE) outlined the Solar Pumping Programme for agriculture and drinking Water. Huge benefits are provided by the government to farmers for using solar pumps (MNRE, 2014). During the FY 14-15 as a part of budgetary allocation, MNRE announced that minimum of One lakh solar water pumps will be installed every year in India, and estimated to achieveinstallation of 10 lakhs solar water pumps by 2020-21 under JNN Solar Mission through State Nodal Agency and NABARD (Sambodhi, 2018).

FINANCING SCHEMES FOR SOLAR PUMPING PROGRAMME

The Government of India has two financing schemes for implementation of the Solar Pumping programme.The first Financing scheme, Central Financial Assistance (CFA), in which farmers received 30 per cent subsidy from MNRE, and additional subsidies can be availed at the state level and remaining cost is to borne by farmers.In Credit-linked capital subsidy scheme, farmers receive 40 per cent capital subsidy from MNRE, 20 per cent beneficiary contribution, and the remaining amount extended as a loan implemented through the National Bank for Agriculture and Rural Development ((GGGI), 2017) The initial capital subsidy scheme supported installation of 100,000 pumps in 2014, and one million by 2020 under the national Solar Mission.

CONCLUSION

Energy is found to be the major cost driver in the operation pumping system for agriculture. Renewable energy was found to be the best alternative not only for reducing the cost of operation but is alsoenvironmental friendly. Installation of Solar water pumps were highly promoted by the government through subsidies from 2013.

The farmers need to understand the feasibility of moving towards new technology from the existing electric and diesel pump sets.

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Pesticides and respiratory health of farmers

Nasrul I. Shaikh[1] and R S Sethi[2]

[1]Research Scholar, [2]Professor and Head,
Department of Animal Biotechnology, College of Animal Biotechnology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, India.

**Corresponding Author:shaikhnasrulislam@gmail.com*

ABSTRACT

Pesticides are group of synthetic chemicals used for the extermination of insects, rodents and unwanted plants. Most of the pesticides have the ability of destruction of a wide variety of pests by disturbing the physiological activities of the target organism resulting in dysfunction and reduced vitality. Agriculture workers are exposed to many pesticides and suffer from respiratory and other symptoms. Pesticide residues from farms have been linked with the health of agricultural workers. Data from various conducted studies demonstrated that pesticide exposure induces lung in-flammation in farmers and workers in agricultural sectors. Furthermore, we need new programme to educate and warn farmers against the ill-usage of pesticides and its harmful effects..

Keywords: Cypermethrin, chlorpyrifos, pesticides,farmers,lung damage

INTRODUCTION

Advancement in medical science has decreased the death rate which directly affected on worldwide human population. World's population has increased drastically in recent decades that have compelled the agriculture sectors to increase food production to meet their demands (Organization 2010). Unfortunately, due to problems such as limited cultivable land, soil infertility and pest infestation farmers are unable to obtain desired yield from their harvest. To meet the demand, the above-mentioned problems required to be resolved i.e. an expansion of land under cultivation and proper pest management (Organization 2010). This scarcity of agricultural areas has forced few of the farmers to outreach the forest and wildlife habitat for agricultural purposes. On the other hand, many farmers in agricultural sectors accepted the modern technology by use of genetically modified crops that are resistant to pests and ultimately giving more yield. Moreover, the organic farming is trending among farmers where bio- pesticides and pheromone are being used to trap pests.

In spite of the mentioned solution to increase the agriculture production, these sectors lose 45% of the outcome which is worth of 6000 crores as a result of pest invasions.

To overcome this loss most of the farmers have started using varieties of the pest management system to protect their farms and to increase production on existing land. Pesticides are group of synthetic chemicals used for the extermination of insects, rodents and unwanted plants. Most of the pesticides have the ability for destruction of a wide variety of pests by disturbing the physiological activities of the target organism resulting dysfunction and reduced vitality, thus generally known as insecticides, fungicides, bactericides, herbicides or rodenticides (Jayaraj et al). About 4.6 million tons of pesticides are used worldwide, and a population of1.8 billion utilize pesticide's globally to deter or kill pests in agricultural settings (Zhang et al 2011). The pesticide consumption has extended beyond expectations, which have resulted in increased cancer cases, development of sexual abnormalities, neurological and immune system disorders in animals as well as in humans. Moreover, around 72million birds lost their lives as a result of unstrained usage of pesticide (Fimrite 2011).

As we say, excess of anything is harmful, the excessive use of pesticide has impacted on the wild life and has affected environment. It has been estimated that only about 0.1% of pesticides reach the target organisms, and the remaining applied pesticides contaminate the surrounding environment and affect the organisms living in it. Exposure of the general population to pesticides occurs primarily through eating pest contaminated food and drinking water containing pesticide residues, whereas substantial exposure to pesticides can also occur in or around the home when any pest's exterminators are called to house. Studies have reported that 50% of the fruits, vegetables and cereals are contaminated with approximate 300 different pesticides (Grewal et al 2017). In case of farmers, exposure mainly occurs during the preparation and application of the pesticide spray solutions and thereafter during the cleaning-up of spraying equipment (Martínez-Valenzuela 2009).

The routes of pesticide entery into the body includes ingestion, inhalation and dermal absorption .Out of the mentioned routes, respiratory inhalation and dermal absorption count for the 10% of total pesticide exposure in agricultural settings as most of the pesticide applicator's works without any respiratory protective equipment or body suit. Pesticides such as organophosphate due to their high lipid solubility are efficiently absorbed by the skin whereas Parathroid insecticides due to the low lipid solubility are efficiently retained through inhalation and ingestion. Many other pesticides such as Chlorophenoxyl herbicides and halogenated fumigant/Methyl bromides are efficiently absorbed by the gastrointestinal tract and inhalation respectively. Furthermore, the possibility of pesticide exposure through skin rises when contaminated suit or tools with residues are reused without proper washing after the tray (Sanborn et al 2002). Besides these routes, ingestion is rare but one of the effective route for systematic inflammation that may lead to death(Maestrelli et al 2009). Respiratory exposure may also occur via airway inhalation of pesticide- contaminated aerosols or particulate matters (PM).

PESTICIDE AND RESPIRATORY HEALTH

Lung has been found to be the first organ to come in contact with after inhalation/ingestion (Dixon et al 2008). Toxicants present in the breathing zone may get absorbed in the nasopharyngeal, tracheobronchial, or pulmonary exchange surfaces of the lung and thus Pesticides besides causing air pollution if inhaled, causes the respiratory problems in human and animals. Chronic respiratory diseasesd due to pesticide causes premature death of more than 4 million of population each year globally whereas around 300 million people suffer from asthma and 210 million people suffer from chronic obstructive pulmonary disease (COPD). Chronic respiratory diseases affect the complete respiratory system from the nose to alveoli and are characterized by inflammatory condition .Farmers, workers and applicators are vulnerable to exposure of pesticide, thus suffers from respiratory diseases, including pesticides associated asthma (Hoppin et al 2007). Moreover, during re-entry into treating fields for plucking of weed, harvesting, and equipment cleaning gets some extra exposure as well. Studies depicted that as the result of pesticide exposure, farmers suffer from respiratory symptoms that include regular cough, wheezing and airway inflammation(Sanborn et al 2002) . In a research conducted in Sri Lanka, it was found that restrictive lung function may result from low-level exposure to organophosphates (Peiris-John et al 200). Another study reported that pesticide exposure may also result in chronic bronchitis among non-smoking farm women. Hashemi et al (2012) reported that pesticide use was associated with an increased risk of wheezing and phlegm among Iranian farmers. We have earlier reported that oral dietary exposure to various pesticides ethion(Verma and Sethi 2020), chlorpyrifos and cypermethrin alone and combination (Sethi et al 2020), 2,4-d (Geetika et al 2019), glyphosate (Pandher et al 2019), fipronil (Pandit et al 2019a,Pandit et al 2019b) and Imidacloprid (Pandit et al 2016)alters the histomorphology and transcription in lung of mice. Several in vivo studies on Mice, Guinea pigs, and rats exposed to different doses of pesticides administered in animal models (Shaikh and Sethi 2020) elicited lung toxicity, pulmonary dysfunction, airway hyperactivity, abnormal lung development, congestion of lungs, pulmonary hemorrhage, irritant effect on lung tissue and hyper responsiveness. Moreover, the studies showed that these pesticide results in lung injury characterized by infiltration of mononuclear cells around perivascular and peribronchiolar regions, sloughing of epithelium and thickening of the alveolar septa in mice (Nazki and sethi 2019).

CONCLUSION

The exposure of pesticides causes pulmonary impairment signified by alveolar congestion, hemorrhage, neutrophil infiltration, emphysematous changes and cellular aggregation in vascular walls or air spaces. These evidences supports the point that pesticide is a major risk for health apart from air pollution. Thus, awareness programs on handling of pesticides are required to set up in rural areas and in society to educate and warn them against the harmful effects of pesticides.

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Roadkill: Highways out of track became new enemy of wildlife- A Problem with its Solutions

Rinkal Sundriyal* and Simran Jeet Singh

CVASC, GBPUA&T, PANTNAGAR

**Corresponding Author: rinkals3k@gmail.com*

Killing the innocents with your speedy cars won't lead you anywhere far. Wildlife and vehicles just can't run parallel to each other on the same road. India, one of the most biodiverse region with 4 (out of 36) world's biodiversity hotspot, is one of the 17 megadiverse countries. To protect this precious wildlife we have 104 National parks, 551 Wildlife sanctuaries, 18 Biosphere reserves and a total of 870 Protected areas. Yet we lose many flora and fauna daily. India's growing network of roads and railways crisscrossing the forest and protected areas, had turned to the tip of the iceberg for wild. These approved projects had fragmented either a national park, a wildlife sanctuary or a tiger reserve.

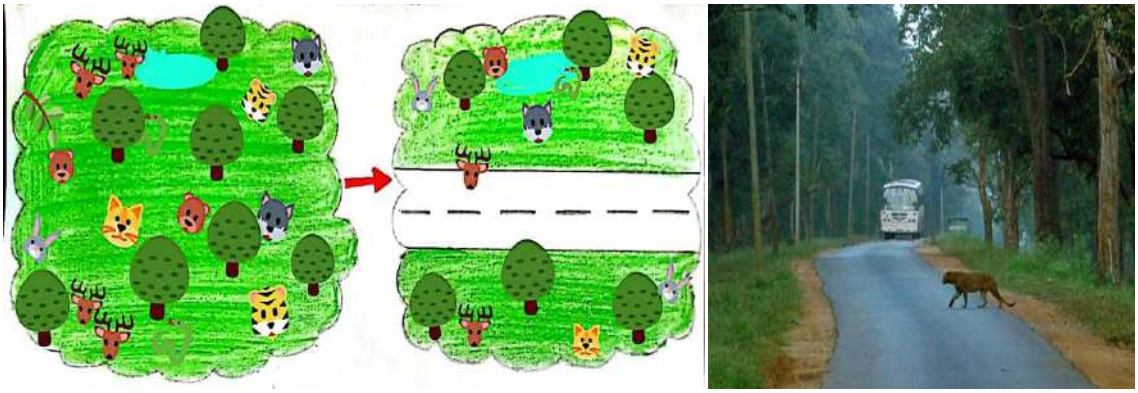


Fig: Habitat Fragmentation

Roadkill refers to those animal/animals that have been struck and killed by motor vehicles on Highways or railway tracks. Wildlife-vehicle collisions (WVC) have increasingly been the Crux of the matter. In 1993 a survey done by 25 schools of New England, United States depicted 1,923 roadkills. They found that out of these animal deaths 81% were mammals, 15% birds, 3% reptiles and amphibians and rest 1% were indiscernible.

In 25th Jan, 2018 the Hindustan Times newspaper posted a data that was collected by Delhi-based NGO Wildlife Protection Society of India (WPSI) from various forest departmentsacross the country.They had recorded 665 roadkills (431 road accidents and 234 train accidents) from 2012-2017 out of which about 40% (256) of

the roadkills were leopards, followed by elephants (100) of which 95 died in train accidents.

a.  b. 

Fig: a. A Deer crossing the road at Bandipur Tiger Reserve | Photo credit: P. Velmurgan (Source: The Hindu newspaper article of 30th March, 2016)
b. Monkeys rushing towards road for grabing the food items thrown by car owner.

The animals that left alive behind have to suffer intense pain with lifelong deformities. We all must have seen monkeys who get maimed during road accidents. People threw food in the roads with the intention to feed them, unaware of the danger that could be a cause of serious injury for them. Also many animal deaths remain unreported as culprit either utilize them as their meal (Venison or Game meat or Bush meat) which not only make our endangered/threatened species to skate on thin ice of extinction but also disturb the food chain as the scavengers (like Vultures) can't get their meal easily. Or they ran away without informing the authorities due to which some animals have to lose their precious life which could be saved by proper treatment. To solve this problem the Wildlife Trust of India (WTI) and David Shepherd Wildlife Foundation have launched a mobile application namely RoadWatch that allow citizens to report wildlife roadkills from any part of country in order to trace the most sensitive area undergoing more number of roadkills.

Fig: The RoadWatch app help's WTI and DSWF to document wildlife roadkills across the country.

Before we go the solutions, we need to understand about animal's behaviour. What compels them to come out of their secure land and cross the road? Pack of wolves, for example, mark large territories and travel so far in search of food, in search of companions during breeding season and for other resources. This concept is applicable for many animal species like elephants and wild cats. This put them every day in the danger of collision with the vehicles. Well it's confirmed that we are the one who enter in their empire and interfere with their natural behaviour.

A project named "**P**rovide **A**nimals Safe **T**ransit on **H**ighways (**PATH**)" was initiated by the Environment Conservation Group in 2015, to study the impact of roads on wildlife. A team of 5 wildlife conservationists led by Mr. R. Mohammed Saleem travelled through

more than 30 wildlife sanctuaries across 22 states (more than 17,000 Km) to study and spread awareness on road kill(as a part of all India awareness expedition on roadkills). Mitigation methods like signage alerting vehicles to wildlife crossing were also documented.

Fig: A campaign vehicle to spread awareness about road kills of animals being flagged off by Director of Tamil Nadu Forestry Academy Rajiv K. Srivastava in Coimbatore. (Source: The Hindu Newspaper article of 9th Feb, 2016)

As a method of mitigation, several caution signs across the roads and railways were established. These warning signs make drivers attentive, hence are effective against in reducing wildlife collision rate but do not solve the habitat fragmentation problem. These cautionary signs are already in use at Rajaji national park in Uttarakhand and Mahananda wildlife sanctuary in West Bengal.

Fig: The caution sign boards across the Railway lines

Here are some methods that could solve the problem.

ANIMAL BRIDGES/ WILDLIFE CORRIDORS and UNDER TUNNELS:

Make a bridge above the roads connecting the fragmented lands and cover the side lane of rest of the road with fences to inhibit animals crossing through that area. Also these bridges should look green like their usual habitat so that they become familiar to it and won't get stressed by the sight of cars. Behaviour of multiple species should be kept in mind for successful use of these corridors as predator and preycan't move peacefully from the same path. Each corridor must be designed with a target species in mind. An underpass (a route for animals passing below the road) that works for a deer will not work for amphibians. Also routine maintenance of these corridors is essential for their effective use.

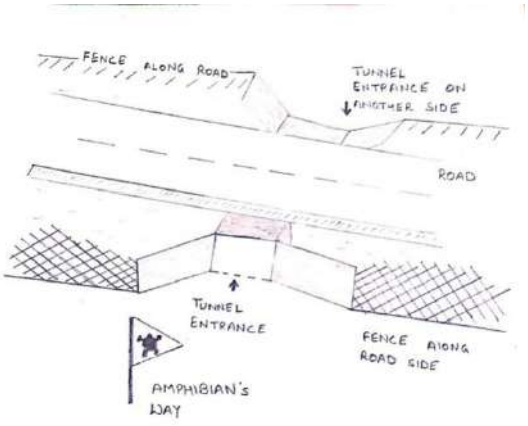
Banff National Park in Canada is home to more than 25 wildlife overpasses across the TransCanada highways. Over 600 underpasses and overpasses exist in the Netherland.

a. 

b. 

Fig: a. Wildlife overpass in Banff National Park, Canada
b. A deer crossing underpass in India (Source: Times of India newspaper article OF 7th Feb, 2020)

For amphibians, animal tunnels or ducts underneath the roads are beneficial along with road side barricades. This could be effective to stop roadkills of amphibians in Western Ghats.
Thermoregulation could be considered as the main reason behind the roadkill of snakes. So some platform, away from the roads should be constructed that allow them to bask under the sun.

a. 

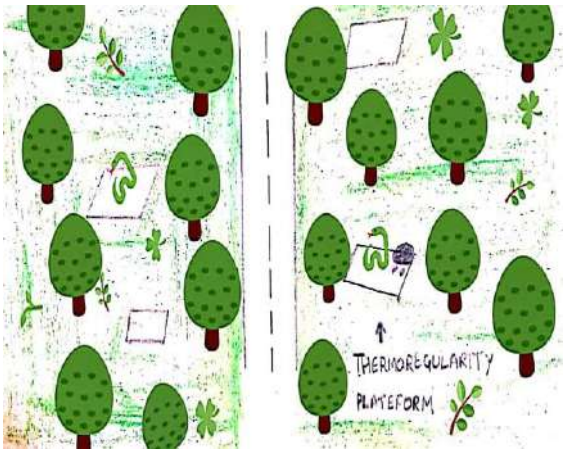
b. 

Fig: a. Under tunnel for amphibians, b. Thermoregulatory platforms for snakes

WARNING or ALERT SYSTEM:

Animal Detection System (ADS) flash warning signs to alert the motorists after detecting large animals through the sensors. At night, solar powered alert system could be used to make driver attentive towards the presence of animals sensed by sensors. But ADS detect only large animals, also it do not ensure safe passage of animals after a certain traffic volume in roads.
The Opto-acoustic Deterrent used in European and North American countries is an example of ADS.
Sri Lanka Railways Department proposed thermal cameras mounted on railway engine of trains routed through Jaffna, to detect animals up to 1Km away and avoid collision (Anonymous, 2014).

Use of some gadgets that imitate natural alarming sounds or calls can be implemented to keep animals away from the railway tracks. Ultrasonic wind-driven whistles are good example. They are cheap and simplest way to avoid wildlife-vehicle collisions. A product named Save-A-Deer whistle is available in amazon.com site. When mounted in vehicle moving at 35 mph or faster, this whistle produce an alert sound that keeps deer, moose, elk and kangaroos away and thus prevents accident. Similar to this product, a gadget producing bees sound should be designed in order to keep elephants away from roads and railway tracks. In 2004, the Polish National Railway introduced UOZ-1, based on this idea.

a.  b. 

Fig: a. Image showing UOZ-1 (A white coloured cylinder like which emits natural sounds) installed across the Railway line
b. A car with installed Save-A-Deer whistle.

CANOPY CONNECTIVITY:

This can be beneficial for monkeys to cross the roads. Although it's not so effective in the areas prone to heavy rainfall as tree can easily fall due to heavy rainfall. Also it is risky for the vehicle occupants as trees could cause accident or could block the roads.

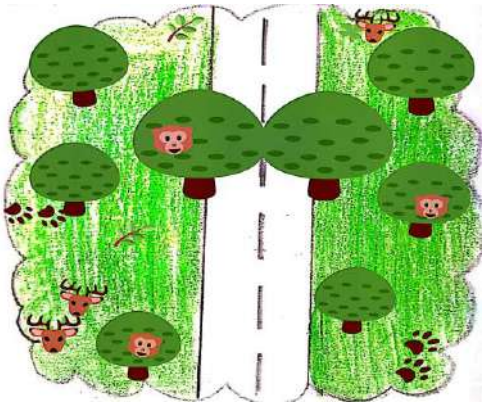


Fig: Canopy connectivity for monkeys.

Fluorescent Antler paints, Reflective collars and Electromagnetic wildlife detectors are some other methods that could warn the drivers at night from the nearby wild animals.

CONCLUSION

Road kill not only make our wildlife dead but also it is a distasteful sight for the economy based on tourism. It not only cause threat to our animals but can cause injury/death to vehicle occupant as well. Hence being the superior of all the species on this Earth and a well responsible citizen, it's totally our responsibility to conserve our

companions. There is a need to take immediate all possible steps in order to protect these speechless innocent creatures.

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Success Stories on Empowering Farmers through Management of Shoot Gall Psylla in Mango

S.S. Singh

G.B. Pant University of Agriculture and Technology, Krishi Vigyan Kendra, Dehradun, Uttarakhand
**Krishi Vigyan Kendra, Almora, Uttarakhand INDIA*

**Corresponding Author: sssindia02@gmail.com*

Mango (*Mangifera indica* L) is one of the socio-economically most important fruit crop of India. Besides fruits, various parts of mango such as leaves and wood are used in almost all our religious and social functions. In addition to fresh fruits, several processed and value added products are also prepared from mango fruits. During 2015-16, mango production in India was 18.643 million metric tons from 2.209 million ha with 8.44 metric tons/ha productivity. It is expected that the mango production in India will be 20.295 million tons from 22.67 million ha (Anonymous, 2017). The sub-tropical regions of Uttarakhand including Dehradun occupied an area of 40211 ha with total production of 147272.70 metric tons and, as such the productivity comes out to be 3.66 metric tons/ha. The terai regions of North India, despite having one of the most fertile soils in the world and excellent climate for mango cultivation have only 43 % mango productivity than what is recorded at National level (8.44 MT/ha). In addition to alternate bearing, the incidence of shoot gall psylla (*Apsylla cistellata* Buckton) infesting mango shoots is one of the major constraints attributed to low productivity of mango in Uttarakhand. Mango shoot gall pyslla, *Apsylla cistellata* Buckton (psyllidae: Homoptera) is the most devastating pest of mango in *terai* region of India, spread over Uttarakhand, Uttar Pradesh, north Bihar and West Bengal. The nymphs of this pest suck the sap and exude whitish sticky droplets which gradually dries up later on. The affected buds get converted into hard conical galls inside which the psyllid nymphs develop into adults. Feeding of nymphs and subsequently secretion of certain chemicals results in the formation of hard conical green shoot galls in place of apical and axillary buds, in which they later enter, feed, develop and grow till adulthood (Shukla and Mishra,2005; Srivastava *et al*. 1982). Due to transformation of apical/terminal reproductive and vegetative buds of the affected mango shoots into galls therefore later on the affected branch practically becomes unfruitful in the season. The galls are generally observed during October-November and continue up to March-April when the adults emerge out of the galls. Thus incidence of pest adversely affects the flowering and fruit setting. In due course of time, the infested branches later dry up.

Depending on the severity of infestation, this pest may cause loss of fruit yield to the tune of approximately 20 to 60 per cent. Heavily infested trees may yield only 10-40 kg fruits/tree against a potential normal yield of 250-300 kg from a healthy tree (Singh and Yadav, 2007). More than 3000 ha of mango orchards are estimated to be badly affected due to infestation of shoot gall psylla in Dehradun, Nainital and Udham Singh Nagar districts of Uttarakhand which causes an economic loss of Rs 70-80 crores annually (Singh *et al*., 2015). The survey conducted in different parts of mango growing areas of Dehradun and discussion held with farmers revealed that due to lack of knowledge about the pest most of the farmers do not resort to its management including application of insecticide. As a result, the infestation of mango orchards in the study area has attained alarming severity resulting into significant reduction in fruit yield (40-50 kg/tree) as against the potential fruit yield of 250-300 kg/tree from a healthy orchards at full bearing age and leading to huge economic loss to the orchardists. Insufficient knowledge of the mango orchardists about the nature and severity of the problem could be attributed as one of the most important factors in increased incidence of shoot gall psylla on mango in Dehradun as well as other parts of *terai* region.
Keeping in view the importance of mango orchards and damage caused by the pest drew attention of stakeholders towards farmer's participatory intervention for effective management of shoot gall psylla in mango in the target areas.

WHEN, WHERE AND BY WHOM THE PROJECT WORK WAS CONCEPTUALIZED?

The project was conceptualized in year 2011 at KVK, Dhakrani, Dehradun by me for effective management of shoot gall psylla of mango in Dehradun district of Uttarakhand. Mango is commercially important fruit crop intensively grown in Dehradun. Mango is grown in about 6337 ha area with total production of 10267 MT and productivity is 1.62 MT/ha in Dehradun district of Uttarakhand. The major reason of low productivity of mango in Dehradun and other parts of Uttarakhand was high incidence of shoot gall psylla. More than 3000 ha area was badly affected with its incidence in Dehradun, districts of Uttarakhand. But from the last one decade incidence of shoot gall psylla in mango posed serious problem among farming community because this devastating pest caused direct damage to the mango crop which adversely affected the productivity. Incidence of shoot gall psylla causes formation of galls on the leaf axils which result in inhibition of inflorescence and most of the affected branches later dry up. About 20-30 per cent farmers were applying insecticides such as monocrotophos, quilanphos and dimethoate recommended earlier for the control of shoot gall psylla but it has been seen that these insecticides were not giving any relief to the farmers from the last 8-9 years. It may be due to continuous use of these insecticides and change in agro environmental conditions. Accordingly, I have made intervention on management of shoot gall psylla in mango.

Was any diagnostic survey undertaken to provide a basis for the formulation of the project? If so, what were its salient findings?

Shoot gall psylla was one of the serious pest of mango in Dehradun which causes enormous economic loss to the growers. According to an estimate about 3000 ha area were badly affected with the incidence of Shoot gall psylla. The survey conducted for its effective management revealed that some farmers used monocrotophos, quinalphos and dimethoate insecticides for the control of this pest but these insecticides did not provide any relief to the farmers from menace of this pest. It was also observed during diagnostic survey that most of the farmers were not using any insecticides for the control of shoot gall psylla because of the very poor awareness. Hence, realizing the importance of mango crop and economic loss caused by Shoot gall psylla, diagnostic survey was conducted in the affected mango orchards of Dehradun. The researches carried out on management of shoot gall psylla in Uttarakhand and other parts of the country envisaged that 3 applications of monocrotophos, quinalphos and dimethoate in second fortnight of August at an interval of 15 days have been recommended. Keeping in view the recommendations made by various scientific organizations, monocrotophos, quinalphos and dimethoate were applied three times at 15 days interval from the IInd week of August, 2011 on 2100 mango trees of Shri Madan Pal Singh Pundir and Shri Mohammad Farooq (Village Badwala, Block Vikasnagar, Dehradun). But these insecticides were unable to provide any control from infestation of shoot gall psylla. Realizing the seriousness of the pest, I approached ICAR-CISH, Lucknow who recommended two application of thiamethoxam 1 g/lit water + profenophos 2 ml/lit water can be used for most effective control of shoot gall psylla in mango.

1. The incidence of shoot gall psylla in mango orchards was very serious problem from the last one decade. Its incidence was increasing year after year due to non adoption of any effective control measures.
2. Keeping in view the serious problem of shoot gall psylla, I took intervention for its effective management.
3. Accordingly, I conducted diagnostic survey in the affected areas and organized meeting with the farmers to find out their views in which it was found that about 3000 ha area of mango badly affected with the incidence of shoot gall psylla.
4. Diagnostic survey was conducted in 42 villages where incidence of shoot gall psylla was a major problem. During diagnostic survey in the villages, group discussion with the farmers was held to formulate the strategies for its effective management.
5. It has been emerged out from the discussion and meeting with the farmers that farmers were aware about the incidence and losses caused by the pest but they were not aware about its effective management due to lack of knowledge.

SOCIO-ECONOMIC AND TECHNOLOGICAL RELEVANCE OF THE PROJECT OBJECTIVES

The incidence of shoot gall psylla has adversely affected the socio economic condition of the mango farmers in Dehradun. Due to high incidence of shoot gall psylla, farmers were getting very low productivity and income from mango cultivation. Poor productivity of mango has posed serious threat for the farmers because of very low return. It was recorded that heavily infested trees yield only 40-50 kg of fruits against a normal yield

of 180-200 kg from a healthy tree. Earlier farmers were getting this much yield from their orchards but due to incidence of shoot gall psylla from the last one decade, the socio economic condition of the farmers badly affected. Technologies were available for effective management of shoot gall psylla but farmers were not aware. Most of the farmers were in opinion that this devastating pest could not be controlled thereby they had lost their hope. Thus technological intervention was made by educating the farmers on various management aspects of shoot gall psylla.In order to mobilize the farmers at large scale, campaign on management of shoot gall psylla was organized which attracted the attention of farmers and developed faith and confidence among them. Two spraying of thiamethoxam 1 g per liter of water + profenophos 2 ml per liter of water + sticker 1 ml per liter of water was done at Badwala village of Vikasnagar block of Dehradun during second fortnight of August to first week of September, 2013 at fortnightly interval in 21 ha area. The spraying of these insecticides reduced the incidence of shoot gall psylla up to 95 per cent. Due to effective management of shoot gall psylla, farmers harvested 4000 Q. mango from 21 ha area during June to August, 2014.

The results recorded from mango orchards of Badwala village were very encouraging and drew the attention of farmer's of nearby villages mainly due to enhanced fruit yield of mango. Many farmer's showed keen interest for adoption of this technology, as a result area under management of shoot gall psylla increased from 21 ha in 2013-2014 to more than 2600 ha during 2017-18. The intervention resulted in enhanced additional income of mango growers from Rs. 0.21 crores in 21 ha during 2013-14, Rs 0.9 crores from 200 ha orchards during 2014-2015, Rs 5.06 crores from 1200 ha orchards during 2015-2016, Rs 8.46 crores from 2000 ha orchards during 2016-2017 and further Rs. 13.82 crores from 2600 ha area during 2017-18. Thus the intervention resulted in generating an additional estimated income of Rs 28.45 crores to the mango growers during five years of farmer's participatory management of shoot gall psylla in mango.

The implementation of the project on management of shoot gall psylla gave tremendous impact in effective management of shoot gall psylla and improving the productivity and income of the farmers. Hence, socio economic conditions of the farmers increased. Such type of intervention was not made earlier by any agency for management of shoot gall psylla.

1. The intervention on management of shoot gall psylla helped the farmers in getting additional income of Rs 28.45 crores from the last five years. This milestone was achieved only by mobilizing the farmers and creating awareness among them by organizing campaign and training.
2. The technology is very viable and sustainable because I have not given any financial assistance to the farmers by any department including KVK. The farmers purchased the insecticides themselves on my recommendation and applied in their orchards and received outstanding result.
3. The impact of technology can be observed that I had started the implementation of technology in 21 ha area during 2013-14 which has increased to more than 2600 ha

area in 2017-18 under management of shoot gall psylla. This shows the socio economic and technological relevance of the project objective.

THE METHODOLOGY USED FOR IMPLEMENTING THE PROJECT

The incidence of shoot gall psylla was managed by conducting training, campaign, field visit, diagnostic survey, meeting with farmers, group discussion with them, distribution of literature during farmers meetings. I have also taken the help of print and electronic media in circulation of technology for management of shoot gall psylla in mango. Farmers' participatory demonstrations were also conducted to create awareness among mango growers about effective management of this devastating pest. During farmers' participatory demonstrations expenditure incurred on insecticide was borne by the farmers themselves. On the recommendation of ICAR-CISH, Lucknow, application of insecticides such as thiamethoxam 1 gm per liter of water + profenophos 2 ml per liter of water + sticker 1 ml per liter of water in the middle of August to first week of September, 2013 has been applied twice at fortnightly interval for management of shoot gall psylla in mango. The results obtained from the Badwala village of Vikasnagar block of Dehradun in 21 ha area gave tremendous impact on mindset of the farmers who were earlier in opinion that this devastating pest could not be controlled. The campaign, training, survey and demonstrations and results obtained from the Badwala village completely changed the mindset of the farmers. The result of the Badwala village attracted the attention of mango growers towards adoption of this technology due to which area under management of shoot gall psylla increased from 21 ha in 2013-14 to more than 2600 ha in 2017-18.

The diagnostic survey was undertaken in Dehradun district of Uttrakhand during 2013-14, 2014-15, 2015-16, 2016-17 and 2017-18 to find out the incidence of shoot gall psylla on mango and impact of insecticides used by the farmers. Initially, 10 farmers were identified for discussion and their views on incidence of shoot gall psylla were recorded. A tool based on questionnaire depending upon the popular farming in the targeted villages was utilized in view of minimizing biasness and uncontrolled error.

Accordingly, to disseminate the technology for large scale adoption and larger benefit to mango growers, interventions were made through participation of the farmers. In order to mobilize the farmers, campaign on management of shoot gall psylla was organized in the villages under study, where incidence of shoot gall psylla in mango was comparatively more serious. During campaign, farmers were educated on various aspects of the pest such as nature of damage, life cycle, symptoms, effective insecticides in earlier studies i.e thiamethoxam and profenophos, their dosages, time of application etc. Hence, these insecticides were recommended to the farmers for two applications in their orchards during second fort night of August to first week of September. Demonstration conducted on two applications of thiamethoxam + profenophos in 35 year old, mango orchards covering 21 ha at Village: Badwala, Block:Vikasnagar, District: Dehradun, Uttarakhand during 2013 found most effective in management of shoot gall psylla.

The data on incidence of shoot gall psylla was recorded on 10 randomly selected trees in each village with the help of farmers. Similarly, data was taken on drying of branches from the same 10 trees in which incidence of shoot gall psylla was recorded with the help of farmers in the selected villages. Farmers were technically trained to ensure participatory approach in recording the observations on various characters under study. The data on drying of branches was also recorded from 10 trees in each village with the help of farmers. During study, observations pertaining to number of fully formed galls per 10 twigs were recorded in the month of November-December, as galls in the leaf axils were visible by October-November. The data on fruit yield (kg/tree) was also recorded from 10 randomly selected uniform trees and average worked out in all the villages during June-July.

Two spraying of thiamethoxam + profenophos were done by the farmers of all the selected villages in their orchards during second fort night of August to first week of September. The observations on various parameters such as number of galls formed/ 10 twigs, drying of branches/10 trees, yield kg/ha. The gross and net returns were also calculated to assess the impact of insecticides on economic implications.

THE SALIENT OUTPUTS OF THE PROJECT

Trainings organized on management of shoot gall psylla in mango

Topic	No. of trainings conducted	No. of farmers benefited
Management of shoot gall psylla	67	670

The farmers' participatory demonstrations conducted at village-Badwala of Vikasnagar block in Dehradun district in 21 ha area through application of insecticides such as thiamethoxam 1 gm per liter of water + profenophos 2 ml per liter of water + sticker 1 ml per liter of water in the middle of August to first week of September, 2013 at fortnightly interval has completely changed the mindset of the farmers by very effective management. Due to management of shoot gall psylla, the farmers harvested 4000 Q. mango from 21 ha area and earned gross income of Rs. 42.66 lacs during June-August, 2014 as against gross income of 21 lacs from previous years. The aditional income earned by the farmers due to management of shoot gall psylla was Rs. 21.0 lacs from 21 ha area.The increase in yield and income was mainly due to management of shoot gall psylla. This intervention has given tremendous impact on the farmers of village Badwala and neighbouring villages. This impact of Badwala was intensively popularised by me among mango growers of other areas of Dehradun.

The results of the demonstrations of village Badwala encouraged me to disseminate this technology on a large scale. Accordingly, I started campaign in July-August, 2014 to July-August, 2018 and tried to convince the farmers about the experiences gained at village Badwala. The campaign and spread of technology through print and electronic media enabled the farmers to apply recommended insectices i.e. thiamethoxam 1 gm per liter of water + profenophos 2 ml per liter of water + sticker 1 ml per liter of water

in the middle of August to first week of September, 2014 twice at fortnightly interval in 200 ha area. The data recorded randomly from October-December, 2014 on the treated orchards reveald that 90-95 per cent of shoot gall psylla was controlled. The result obtained in June-August, 2015 was really very encouraging and given remarkable impact on farming community as farmers harvested 40,000 Q. mango and have earned more than Rs. 0.9 crore additional income from 200 ha. area due to management of shoot gall psylla. I have started the campaign on management of shoot gall psylla again in July-August, 2015 also due to which farmers have applied above insecticides in about 1200 ha area. The observations recorded in October-December, 2015 and meeting held with the farmers indicated that more than 95% incidence of shoot gall psylla had been managed. It is estimated that farmers harvested 2,30,000 Q. mango and earneed additional income of about Rs. 5.06 crores from June-August, 2016. The campaign was again organized by me during July-August, 2016 and due to which farmers have applied the recommended insecticids in more than 2000 ha area and received about 3,50,000 Q. yield of mango with additional income of Rs. 8.46 crores during June-August, 2017. Similarly, farmers applied the recommended insecticides in more than 2600 ha area during 2017 and obtained about 4,20,000 Q. yield of mango with additional income of Rs. 13.82 crores in June-August, 2018. Within 5 years area has been increased from 21 ha in 2013-14 at Badwala village of Vikasnagar block of Dehradun to more than 2600 ha in 2017-18 under management of shoot gall psylla. According to an estimate, the farmers earned about Rs. 28.45 crores additional income from the last five years (2013-14 to 2017-18).

1. The area under management of shoot gall psylla in mango increased from 21 ha in 2013-14 to more than 2600 ha in 2017-18. About 670 farmers have been benefited directly due to management of shoot gall psylla. This happened due to technologiacl intervention made by me by mobilizing and sensitizing the farmers and by creating awareness among them through organization of campaign.
2. From the last four years (2013-14, 2014-15, 2015-16, 2016-17 and 2017-18) farmers earned Rs 28.45 crores as additional income due to management of shoot gall psylla from their mango orchards.

The technological intervention made by me has healped the farmers in effective management of shoot gall psylla which was a serious problem from the last one decade. The intervention develpoed cridibility of the farmers about the KVK, Dehradun. The trust and faith of the farmers achieved in management of shoot gall psylla are helping KVK, Dehradun in making other such type of interventions among the farming community.

THE IMPACT OF THE PROJECT ON THE KNOWLEDGE, SKILLS, ATTITUDES AND ADOPTION RATE OF RECOMMENDED TECHNOLOGIES BY THE TARGET POPULATION

Two application of thiamethoxam 1 g/lit water + profenophos 2 ml/lit water + sticker 1 ml/lit water were found most effective and controlled the incidence of shoot gall psylla upto 95 per cent. The impact of this technological intervention gave tremendous boost

to spread this technology, in which about 670 farmers from Vikasnagar, Sahaspur,Kalsi and Doiwala Blocks of Dehradun for application of these two insecticides have been mobilized. Application was done by the farmers in their mango orchard in about 2600 ha area for management of shoot gall psylla up to August-September, 2017. The observations recorded from October to December, 2017 indicated that farmers were fully convinced about the performance of these insecticides. The farmers who were earlier in opinion that management of shoot gall psylla is almost impossible have changed their attitude due to technological intervention and its tremendous impact on shoot gall psylla management. This approach has significantly developed faith and confidence of the farmers about the technology and also improved their knowledge, skills and adoption rate. Farmers were not aware about the thiamethoxam and profenophos insecticides and their impact on management of shoot gall psylla. When these insecticides applied in August-September, 2013 at Badwala village of Vikasnagar block of Dehradun in 21 ha area and result came in terms of management of shoot gall psylla upto 95 per cent and significant increased in yield has changed the knowledge, skills and attitude of the farmers. Within five years the area has been increased from 21 ha in 2013-14 to more than 2600 ha in 2017-18.

1. The implementation of the project on management of shoot gall psylla gave tremendous impact on knowledge, skills, attitudes and adoption rate of recommended technologies by the target population because incidence of shoot gall psylla was a major problem from the last one decade due to lack of knowledge, skills, attitudes and adoption rate of recommended technologies by the target population.
2. The impact of Badwala village of Dehradun district in 21 ha area during 2013-14 has completely changed the mindset of the farmers. Earlier farmers were in opinion that this devastating pest can not be controlled but when the result came of Badwala village which significantly improved the productivity and income of the farmers of Badwala village from 21 ha area has completely changed the perception of the farmers. They have started thinking that this serious pest can be managed by adoption of recommended technologies.
3. The impact of Badwala village in 21 ha area during 2013-14 and its publicity by me among the farmers has attracted their attention for adoption of this technology due to which the area under management of shoot gall psylla which was 21 ha in 2013-14 has increased to more than 2600 ha in 2017-18. This challenging milestone has been achieved by changing the mindset of the farmers only when the result of Badwala village came.
4. About 3000 ha area were badly affected with the incidence of shoot gall psylla amongst which more than 2600 ha area brought under the management of shoot gall psylla from the last five years. This shows the impact of technology adopted by the farmers on my recommendation.
5. Similarly, effective management of shoot gall psylla in mango generated additional income of Rs 28.45 crores from the last five years. The intervention made by me directly benefited about 670 farmers of the district. This happened due to

mobilization and sensitization of the farmers and by creating awareness among them. In order to popularize this technology among farmers, we have organized campaign on management of shoot gall psylla in almost all the villages where mango is commercially grown and incidence of shoot gall psylla was a serious problem.

6. The intervention made on management of shoot gall psylla and its tremendous impact in terms of improving the productivity and income of the farmers has broaden the views of the farmers, their perception and mindset about adoption of viable technology.

Intervention made on selected villages in Dehradun district of Uttarakhand on management of shoot gall psylla in mango

S.No	Name of Village	Block	Remarks
1	Katapatthar	Vikasnagar	Two applications of thiamethoxam 1 g per liter of water + profenophos 2 ml per liter of water + sticker 1 ml per liter of water were applied from IInd fortnight of August to Ist week of September at 15 days interval. This intervention helped the farmers in effective management of shoot gall psylla in their mango orchards. The observations recorded and survey made in various parts of Dehradun and meeting held with the farmers during survey revealed that 90-95 percent mango orchards of Dehradun district have completely free from incidence of shoot gall psylla. However, in 2012, about 70 percent mango orchards badly affected with incidence of shoot gall psylla. This challenging task achieved by mobilization and sensitization of the farmers and by creating awareness among them about the adoption and its impact of the
2	Prateetpur	Vikasnagar	
3	Dharmawala	Vikasnagar	
4	Sabhawala	Vikasnagar	
5	Shankerpur	Sahaspur	
6	Rampur	Sahaspur	
7	Charba	Sahaspur	
8	Selaque	Sahaspur	
9	Ramsowala	Sahaspur	
10	Horawala	Sahaspur	
11	Lamberpur	Vikasnagar	
12	Khushalpur	Sahaspur	
13	Kainchiwala	Sahaspur	
14	PArwal	Sahaspur	
15	Ramgarh	Sahaspur	
16	Dobri	Sahaspur	
17	Aamwala	Vikasnagar	
18	Sorna upper	Vikasnagar	
19	JAgatpur	Vikasnagar	
20	Jassowala	Vikasnagar	
21	Jamnipur	Vikasnagar	
22	Badwala	Vikasnagar	
23	Kunjagrant	Vikasnagar	
24	Timli	Vikasnagar	
25	Babugarh	Vikasnagar	
26	Bhimawala	Vikasnagar	
27	Dhakrani	Vikasnagar	
28	Dakpathar	Vikasnagar	
29	Langha	Vikasnagar	
30	Adduwala	Vikasnagar	

31	Judli	Vikasnagar	recommended technology. The impact reflected from Badwala village in 21 ha area during 2013-14 has completely changed the perception and mindset of the farmers who were earlier in opinion that this devastating pest can not be controlled. After the intervention of Badwala village and impact realized in terms of improving productivity and income of the farmers started thinking that this serious pest can be managed successfully. Hence, farmers applied the recommended insecticides at proper time and received the result in terms of improving productivity and income.
32	Majri	Vikasnagar	
33	Tipperpur	Vikasnagar	
34	Jamankhata	Vikasnagar	
35	Ranipokhri	Doiwala	
36	Bhaniawala	Doiwala	
37	Bhogpur	Doiwala	
38	Ghamandpur	Doiwala	
39	Shergarh	Doiwala	
40	Reshammajri	Doiwala	
41	Bulawala	Doiwala	
42	Dudhli	Doiwala	
43	Shyampur	Doiwala	

The impact of the project on the production, productivity, profitability and sustainability of the relevant agricultural production systems

The technological intervention based on two applications of thiamethoxam 1 gm per liter of water + profenophos 2 ml per liter of water in the month of August-September, 2013 at fortnightly interval in 21 ha area proved to be most effective in keeping the incidence of shoot gall psylla below economic injury level and also increased the yield significantly in the mango orchards where farmers had adopted above insecticides. The use of these insecticides has given tremendous impact in increasing the production, productivity, profitability and sustainability of the relevant agricultural production system. Earlier farmers were hardly getting 40-50 kg yield per tree however after intervention farmers receiving 180-200 kg yield per tree, which is 322 per cent higher. This happened mainly due to two applications of thiamethoxam 1 gm per liter of water + profenophos 2 ml per liter of water + sticker 1 ml per liter of water in proper fashion

Impact of the intervention on the production, productivity and profitability in mango

Before Intervention				After Intervention						
Year	**Mean No. of galls formed/ 10 twigs**	**Yield (Q/ha) in infested orchard with shoot gall psylla**	**Income earned by farmers (Rs/ha)**	**Mean No. of galls formed/ 10 twigs**	**Yield (Q/ha) under managed orchard**	**Income earned by the farmers (Rs/ha)**	**Area under management (ha)**	**Yield under management (q.)**	**Gross Income earned by farmers (Rs)**	**Additional income earned by farmers due to management of shoot gall psylla**
2013-14	218.76	62.66	62660	4.97	184.35	184350	21	4,000	0.38 crore	0.21crore
2014-15	231.15	48.21	48210	5.24	192.46	192460	200	40,000	3.8 crores	0.9 crore
2015-16	226.39	43.86	43860	4.89	204.06	204060	1200	2,30,000	24.48 crores	5.06 crores
2016-17	196.17	52.04	52040	3.20	172.82	172820	2000	3,50000	34.56 crores	8.46 crores
2017-18	181.72	46.00	46000	2.80	214.00	214000	2600	4,20000	55.64 crores	13.82 crores
										28.45 crores

THE DIFFUSION OF THE PROJECT IMPACT ON THE NEIGHBORS OF THE DIRECT CONTACTIES

The survey, visit and interaction held with the farmers show that about 670 farmers have implemented the technology on management of shoot gall psylla in their mango orchards from the last five years (2013-14 to 2017-18).In 2013-14 spraying of recommended insecticides was done at Badwala village of Vikasbnagar block of Deradun in 21 ha area which has been increased to more than 2600 ha area in 2017-18. According to an estimate more than 670 farmers have adopted this technology for management of shoot gall psylla in their mango orchards. The impact of this technology has also spread in neighbouring districts i.e. Saharanpur in Uttar Pradesh and Udham Singh Nagar and Nainital in Uttarakhand where about 600 ha area covered under management of shoot gall psylla. Mango is commercially grown in Saharanpur district of Uttar Pradesh and Udham Singh Nagar and Nainital districts of Uttarakhand where incidence of shoot gall psylla was also a serious problem. The impact on management of shoot gall psylla in Dehradun reflected the farmers of above districts for adoption of this technology. I have also taken the help of District Horticulture Officers and KVKs for dissemination of this technology in above districts.

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Scientist educating the farmers on management of shoot gall psylla during campaign	Incidence of shoot gall psylla in Mango
	
Opening of galls after adult emergence	Production of Mango in demonstrated orchard

Farmer Producer Organisations: Panacea for the ailing Agriculture sector

Vinod Kumar Bist[1*] and Dr. Preeti Sawairam[2]

[1]General Manager, Nabard, Haryana Regional Office, Sector 34-A, Chandigarh
[2]Assistant Professor, Yashada, Rajbhavan Complex, Baner Road, Pune *411 007*

**Corresponding Author: bistvinod64@gmail.com*

ABSTRACT

Agriculture in India is confined in large number of fragmented small holdings and providing employment to about 55 per cent of workforce. It has contributed to overall growth of the economy and have helped in reducing poverty, giving gainful employment and food security to the majority of the population. However, the current day agriculture is beset with many issues like lack of market linkages, timely credit facility and inputs, availability of farm mechanization, poorly developed supply chain etc. A sustainable solution to these issues has been addressed to a large extent by promotion of farmers' collectives or the Farmers' Producer Organisations. Most of the 8,500 FPOs promoted by SFAC, NABARD and also various other organisations are nascent and have very less business volumes as also membership. GoI has recently been very proactive and launched many benefits and incentives for the FPOs. With more capacity building and better performance of these FPOs, they are going to turn farmers into businessmen and the programme is going to change the plight of farmers. FPOs have the potential to transform marginal and small farms from subsistence farmingto market-oriented commercial farms, provided that the promotion and nurturing of FPOs is implemented in a mission mode.

BACKGROUND

Agriculture in India is predominantly production oriented confined in large number of fragmented small holdings and plays a pivotal role in the Indian economy. By providing employment to about 55 per cent of workforce, it has contributed to overall growth of the economy and have helped in reducing poverty, giving gainful employment and food security to the majority of the population. The highly fragmented, scattered and heterogeneous landholding coupled with the rising cost of cultivation and limited access of small/marginal farmers to public resources and markets, have proved agriculture an unviable proposition. These factors along with issues like lack ofmarket linkages, timely

credit facility and inputs, availability of farm mechanization,poorly developed supply chain etc. have resulted in high exploitation of farmers by intermediaries and money lenders. Incidentally, small and marginal farmers constitute around 85% of the total land holding and hold around 44% of the land under cultivation. In order to address such constraints of small farm holders in production and marketing, collectivization of these farmers to leverage economies of scale in the form of groups called FPOs or Farmers' collectives is a trajectory to achieve the target of doubling of farmers' income.

The situation, hence, calls for major structural reforms and transformational initiatives by way of increased investments for enhancing agriculture productivity and carrying out reforms in agricultural marketing. A sustainable solution to these issues has been addressed to a large extent by promotion of farmers' collectives or the Farmers' Producer Organisations. In fact, the concept of FPO begun during 2011-12 when a pilot project was launched in partnerships with State governments. The project was implemented through the Small Farmers Agri-Business Consortium (SFAC). The pilot programme showed encouraging results and over three lakh farmers were mobilised under village-level farmer interest groups. The successful pilot by the SFAC sooner paved the way for other organisations like NABARD and various State governments promoting large numbers of FPOs.

Collectivization of farmers –ensures forward and backward linkages

CURRENT STATUS OF FPOS

FPOs or the farmers' collectives have membership mainly comprising small/marginal farmers. Nearly 8,500 FPOs (including Farmers' Producer Companies or FPCs) are in existence in the country, which have been promoted under various initiatives of the Govt. of India (includes nearly 850 FPCs promoted by the SFAC) besides other collectives promoted by State Governments, other apex organizations like NABARD over the last 8-10 years. In fact, NABARD has promoted about 4,500 FPOs with the support of the Farmers' Producer Promoting Institutions (POPIs) under the PRODUCE fund of GoI and their own schemes. Of these, most of them are registered as Producer Companies and the remaining as Cooperatives/ Societies, etc. Majority of these FPOs have shareholder membership ranging from 100 to over 500 farmers and are in their nascent stages of operation. They require handholding and technical support besides adequate capital and infrastructure assistance including market linkages for sustaining their business operations. Many of the FPOs are not working well and despite support by the implementing agencies as also the FPO promoting agencies. There are many challenges being faced by these FPOs. Most of them have poor resource base and are not

financially strong, as they mainly comprise of small and marginal farmers. Lack of trained manpower, they not being run in a professional manner, weak financials etc. results in rendering poor services to their members. Further, financial institutions for want of collaterals and credit history often shy away from extending credit to the FPOs.

PRO-ACTIVE STEPS TAKEN BY GOI

The GoI has recently launched an ambitious programme to form 10,000 Farmers Producers Organisations (FPOs) with a budgetary allocation of Rs 4,496 crores within five years across the country aimed primarily to help small and marginal farmers. The scheme is a part of the Government's efforts to double farmers'income and also empower them with the ''economies of scale".

FPOs – redefining farming

The government will promote the FPOs under ''One District One Product" cluster to promote specialization and better processing, marketing, branding and exports. The Government has also addressed the issue of providing equity grant to strengthen the financial base of these FPOs. The equity grant is in the form of matching grant up to Rs.2,000 per farmer member of FPO with a maximum limit of Rs. 15.00 lakh per FPO. This facility will enhance the viability and sustainability of FPOs, their credit worthiness, enhance shareholding of members. The government has also set up a Credit Guarantee Fund of up to Rs 1,000 crores in NABARD and Rs.500 crores in NCDC with equal contribution from the GoI. This will enable the banks and the financial institutions to provide collateral free credit to FPOs by minimizing their lending risks in respect of loans. The credit guarantee cover per FPO will be limited to the project loan of Rs. 2 crore. In case of project loan up to Rs. 1 crore, credit guarantee cover will be 85% of bankable project loan with ceiling of Rs. 85 lakh; while in case of project loan above Rs.1 crore and up to Rs. 2 crore, credit guarantee cover will be 75% of bankable project loan with a maximum ceiling of Rs. 150 lakh.

Incidentally, similar scheme comprising of the equity grant support and credit guarantee fund support is already there for the FPOs and is being implemented by the SFAC and the NABKISAN Ltd. (a subsidiary of NABARD).

Individual members of the FPOs are basically farmers and it is essential to provide them adequate and timely credit so as to enhance the farm productivity. Hence, government has proposed intensification of the Kisan Credit Cards scheme for the benefit of the FPO members.

Government of India has recently passed the Farmers' Produce Trade and Commerce (Promotion and Facilitation) Bill, 2020 and the Farmers' (Empowerment and Protection) Agreement of Price Assurance and Farm Services Bill, 2020. With these bills, the farmers and the farmer groups and traders will have the freedom of option to

barrier-free inter-state and intra-state trade and business outside the physical boundaries of markets. The farmers will not have to pay any cess or levy for sale of their produce and will not have to pay for transportation costs. In addition to mandis, farmers would enjoy the freedom to do trading at farm gate, cold storage, warehouse, processing units etc. Farmers will be able to do direct marketing thus eliminating intermediaries resulting in realization of higher prices. It also allows the farmers or FPOs for engaging with processors, wholesalers, aggregators, wholesalers, large retailers, exporters, and others in a very competitive environment. Price assurance will be given to the farmers even before the sowing of crops. In the case of higher market prices, farmers will be entitled to this profitable price much above the minimum price. It will give access to the farmer to adopt modern technology, better seed and other inputs. It will mitigate the cost of marketing and enhance the income of farmers.10,000 Farmer Producer organizations are coming to existence across the country. Both these bills will prove to be a boon for the FPOs.

NABARD as a pioneer in field of rural credit and rural development is providing lot of support in nurturing the FPOs. The existing FPOs arebeing supported for various capacity and skill development programs as also for marketing initiativesby way of grants. The new FPOs/FPCs are being supported for mobilising more number of producers, FPO establishment and registration, training to BODs/governing body of FPOs, remuneration of CEO, preparation of business Plan, training to CEOs of POs, support to FPO Promoting Institutions and also for the FPOs business development plans.

In a recent study commissioned by NABARD it has been brought out that FPOs, if suitably strengthened, can meet the loan requirements of small and marginal farmers. This will also reduce their dependency on arhtiyas and the commission agents, provided the FPOs are run professionally and are supported by the banking system.

Grading and packing of vegetables – redefining marketing

ISSUES WITH THE FPOSAND EXPECTATIONS

a) Not preparing viable and outcome oriented revenue generating business planning
b) Poor membership and as a result low share capital
c) Capacity and skill development issues pertaining to the members, directors and the CEO
d) Convergence with different government departments which would help them in getting cost free inputs, subsidies and grants as also will address their capacity issues
e) Exposure visits, agricultural university tie ups, expert meetings, etc.

f) Not being able to access bank loan due to lack of collaterals and also absence of viable business plan.
g) Tie up with other FPOs, traders, processors for better marketing of produce directly or through e-kisan mandis.

SOME SILVER LININGS

- Lockdowns have inflicted lot of losses to almost all sectors of economy. However, as per newspaper report, the lockdown period meant a brisk business for the FPCs in Maharashtra. The Maha FPC, a federation of about 360 FPOs in Maharashtra reported a business of about Rs.650crores during the lockdown. Similarly, Sahyadri FPC, a collective of 800 farmers also reported a business of Rs.125 crores during the lockdown. In fact these collectives acted as an alternate marketing platform. The FPCs also procured large quantities of pulses, soybeans and onions on behalf of NAFED.
- NAFED model of e-kisan mandi set up in Pune has roped in 30 FPCs in the district which would supply the farm produce to those traders or retail chains who register themselves in the e-kisan mandi or portal. NAFED's arm i.e. Federation of Farmer Producer Organisations and Aggregators (FIFA) entered into a 51% : 49% joint venture with Maharashtra Farmers Producer Company (Maha FPC), the umbrella organisation of the state's farmer producer companies for the venture. Unlike e-NAM, which focuses on APMCs, the e-kisan mandis will seek to bring farmers, agri-producers, traders and small buyers on a common platform for trading agricultural commodities. An online electronic market will not work unless it is accompanied by proper physical infrastructure. Physical sorting and grading facilities will be established to help farmers get access to an efficient price discovery mechanism.
- Agri start-ups can play a crucial role in filling the void of information asymmetry both on the upstream (supplies to farmers) and downstream (market linkage) side. With the advent of technology, availability of networks in remote rural areas, penetration of smartphones/tablets, cloud-based internet services, remote sensing possibilities, Agri-tech companies have an opportunity to address concerns in the agriculture sector, specifically faced by smallholders.

CONCLUSION

The Farmer Producer Organisations are aimed at providing small farmers a platform to collectively tackle their challenges right from accessing various agricultural inputs to marketing their produce. As per the Hon'ble Prime Minister, the FPOs are going to turn farmers into businessmen and the programme is going to change the plight of farmers as nearly 85 percent of the farmers fall into small and marginal category. Good FPOs will ensure a better future for farmers as the farmers which were only producer till now but through the FPOs, will now be able to negotiate the price of their produce with traders and do business.The government hasalready

Good FPO – ensures better future for the farming community

prepared a ground for the programme and have announced many favourable schemes. FPOs have the potential to transform marginal and small farms from subsistence farming to market-oriented commercial farms, provided that the promotion and nurturing of FPOs is implemented in a mission mode.

Vinod Kumar Bist
General Manager, Nabard, Haryana
Regional Office, Sector 34-A,
Chandigarh

Dr. Preeti Sawairam
Assistant Professor, Yashada,
Rajbhavan Complex, Baner Road,
Pune 411 007