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Information and Communication Technology (ICT) - A Powerful Tool for Transforming Higher Education in India

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ABSTRACT

Information and communication technologies (ICTs) are being used in numerous fields since quite some time in higher education. Apart from making the learning and teaching more interesting, the ICTs offer opportunity to the teacher and taught to gain information. Through the integration of these technologies the communication turns out to be more seamless. Usefulness of ICTs can be measured by way of its usage now in various countries as one of the fundamental things to make teaching and learning more appealing. At the same time ICTs also provide challenge to teacher and students in terms of subject specific ICT resources for each other's understanding with different kinds of activities. It provide more interactive and less didactic approach, where the class can interact with the content and context of the lessons digitally through the ability to capture, combine and manipulate information from a brand of sources.

Keywords: - Information technology, Higher education, Online learning

1. INTRODUCTION

Information played an important role in all societies since the dawn of civilization. However, in recent years its increase in volume and accuracy as well as greater access, have significantly elevated its importance in all aspects of social life. The world community has recognized the revolutionary nature of information society. The world is undergoing an Information and Communication Technology (ICT) revolution, a revolution that has enormous socio-economic implications for the developed and developing countries.

ICT stands for information and communication technologies. ICT refers to technologies that provide access to information through communications. It is similar to information technology (IT). "But primarily focuses on communication technologies. This includes the internet, wireless network, cell phones and other communications medium". In the past few decades, information and communication technologies have provided to society with vast array of a new communication capabilities. "People can

communicate in real time with others in different countries using technologies such as instant messaging, voice over IP and video conferencing, social networking websites like Facebook, V-chat, WhatsApp, Instagram, etc. allow users from all over the world to remain in contact and communicate on a regular basis". Modern information communication technologies have created a global village in which people communicate with others across the world as if they were living next door. "For this reason ICT is often studied in the context of how modern communication technologies affected society". In short, ICT is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning (Khan et al., 2015). "ICTs are often spoken of in a particular context, such as ICTs in education, agriculture, health care, or libraries" (Abe and Adu, 2007).

Since 1990, many countries have been promoting the use of ICT in education, particularly to expand access to and improve the quality of education. So globally, Indian educational systems are under great pressure to adopt innovative methodologies and to integrate New Information and Communication Technologies (NICTs) in the teaching and learning process, to prepare students with the knowledge and skills they need in the 21st century.

2. REVIEW OF LITERATURE

Ozdmemir and Abrevaya (2007) asserted that ICT is reducing the cost per students and expanding the enrolments and makes the provisions for employers and supports enduring learners. Lalitbhushan et al. (2014) conducted a study on "Role of ICT in Higher education: learners perspective in rural medical schools" and concluded that there is a need to foresee the role of technology in education and take appropriate measures to equip the stakeholders for adequate and optimum application of the same. Uttam (2014) revealed in his study that ICT enabled education will ultimately lead to the democratization of education and it has the potential for transforming higher education in India. Further, Mahisa (2014) also revealed that ICT play vital role as a strong agent for change among many educational practices.

3. COMMONLY USED ICT TOOLS

Many ICT tools are available in the modern world that can be used to create and disseminate knowledge. Tools include radio, TV, internet, mobile phones, computers, laptops, tablets and many other hardware and software applications. Certain ICT tools, such as laptops, PCs, mobile phones and PDAs, have implications for education. These devices can be used to provide education and training for teachers and students. Most ICT tools are exaggerated, but until now they did not go well. The use of radio for educational practices has been very popular in the past and is still used by IGNOU in India.

However, one-to-one broadcasting technologies such as radio and television are considered less revolutionary 'ICT' in education because they are used to reinforce

traditional teachers-oriented learning models, in contrast to computers that are considered to be an important tool for training pupils, Centered education model. Successful ICT initiatives meet three objectives: availability, access and demand. Educational ICT tools are not intended for teachers to acquire ICT skills directly, but for teachers to create a more effective learning environment through ICT. Teachers can use ICT tools to take advantage of the use of these tools in content, curriculum, training and assessment.

4. MAJOR ICT INITIATIVES IN HIGHER EDUCATION

India is making use of powerful combination of ICTs such as open source software, satellite technology, local language interfaces, easy to use human-computer interfaces, digital libraries etc. with a long-term plan to reach the remotest of the villages. Community service centers have been started to promote e-learning throughout the country (Bhattacharya and Sharma, 2007). Notable ICT initiatives in higher education in India include:

- ✓ Indira Gandhi National Open University (IGNOU) uses radio, television and internet technologies.
- ✓ National Programme on Technology Enhanced Learning: a concept similar to the open courseware initiative of MIT. It uses internet and television technologies.
- ✓ Eklavya initiative: Uses internet and television to promote distance learning.
- ✓ IIT-Kanpur has developed 'Brihaspati', an open source e-learning platform (Virtual Class Room).

Premier institutions like Calcutta have entered into a strategic alliance with NIIT for providing programmes through virtual classrooms. Jadavpur University is using a mobile-learning centre. IIT-Bombay has started the program of CDEEP (Centre for Distance Engineering Education Program) as emulated classroom interaction through the use of real time interactive satellite technology.

5. ADVANTAGES OF ICT IN HIGHER EDUCATION

Use of ICT in education presents a unique opportunity to solve multitude of challenges quickly as well as at low rate. Here is an overview of advantages of an ICT:-

a. **Motivating Factor: -** The internet can act as a motivating tool for many students. Young people are very captivated with technology. Educators must capitalize on this interest excitement and enthusiasm about the internet for the purpose enhancing learning. For already enthusiastic learners, the internet provides them with additional learning activities not readily available in the classroom.

b. **Fast communication:-** The internet promotes fast communication across geographical barriers. Students can join collaborative projects that involve students from different states, countries or continents.

c. **Co-operative learning: -** The internet facilitates co-operative learning, encourages dialogue and creates a more engaging classroom.

d. **Locating Research materials:-** Apart from communication, research is what takes many people to the internet. There are many resources on the internet than the school library can provide.
e. **Acquiring varied writing skills:-** If students are required to publish their work on the internet, they have to develop hypertext skills. These skills help students gain experience in non sequential writings.

6. CONCLUSION

Information and Communication Technology have become common place entities in all aspects of life. ICTs – which include radio and television, as well as newer digital technologies such as computers and the internet, have been taught as potentially powerful enabling tools for educational change and reform. When used appropriately, different ICTs are said to help expand access to education, strengthen the relevance of education to the increasingly digital workplace, raise educational quality and helping make teaching and learning into an engaging, active process connected to real life. However, the experience of introducing different ICTs in the classroom and other educational settings all over the world over the past several decades suggests that the full realization of the potential educational benefits of ICTs is not automatic. The effective integration of ICTs into the educational system is a complex, multifaceted process that involves not just technology-indeed, given enough initial capital, getting the technology is the easiest part but also curriculum and pedagogy, institutional readiness, teacher competencies, and long-term financing, among others.

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Rural Development and Women Empowerment through Self Help Group's

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Poverty and unemployment are a major problem of developing country like India. Population of India increasing day by day but employment rate is not increasing as excepted.in India poverty in rural area is 25.7 per cent of population and in urban area 13.7 per cent of population which clearly can analysis in rural area poverty is more compare to urban area. More compare to urban area and over all poverty is 21.9 per cent of country population. According to NSSO report 2017-18 overall unemployment rate is almost 6.1 per cent. And condition of unemployment rate in female is worse than male, over all female unemployment rate is 8.5 per cent and in rural unemployment rate is 9.8 per cent, which indicate that in India rural area is more under develop than urban area. Rural development is the process of improving the quality of life and economic well-being of people living in relatively isolated areas. The concept of rural development is very important for a country like India, where majority of population of country is living in rural areas. For such a country, development in the true sense can be achieved only when the rural areas are developed. A major rethinking on the existing strategies of rural development in general and women empowerment, in particular, led to the realization that a new approach is needed to 'help the farmers to help themselves'. By Self Help Group in short mostly known as among people as SHGs. it means it shall include those people who develop themselves by their own efforts. Self Help group is a small, economically homogeneous group of rural poor to save and mutually agree to contribute to a common fund voluntarily which will be lent to the members as per the group decision. SHGs contribute towards the economic development and also plays important role in in poverty alleviation and employment generation in rural areas. These groups provide access to credit to their members through different funding agencies and reduce the dependency on moneylenders and other family members. Moreover, these groups incubate the culture of saving among the members capable of creating an environment of share understanding and collective action. Thus, playing an important role in the promotion of social and economic empowerment of rural people. SHGs have formed a platform for building sense of community, a social support system which boosts the self-

confidence and sense of equality among the members.Performance of SHGs depends upon the awareness of members about overall group objectives as well as the capacity of the group to develop members' managerial and technical skills. An ideal group size of 12-20 farmers (either men or women) shall enhance the group efficiency.
These groups play a significant role in the promotion and enrichment of rural people through training and capacity building and involving themselves in income raising activities, reducing production costs and increase net returns. Its launched almost two decade ago, now a days its plays important role in poverty alleviation and employment generation in rural area.

ORIGIN OF SELF-HELP GROUPS

The origin of Self-Help Groups (SHGs) is the brainchild of Grameen Bank of Bangladesh, founded by Prof. Mohammed Yunus in 1975, who tried out a new approach to rural credit in Bangladesh. Grameen gave loans without asking borrowers either to provide collateral or engage in paper work. In India NABARD initiated SHGs in the year 1986-87 but the real effort was taken after 1991-92 from the linkage of SHGs with the banks. A SHG is a small economically homogeneous affinity group of the rural poor voluntarily coming forward to save a small amount of money regularly, which is deposited in a common fund to meet the members‟ emergency needs and to provide collateral free loans decided by the group. It now addresses the issues of poverty alleviation and empowerment of poor, health, nutrition and other support services especially women, in the rural areas of the country.

THE CONCEPT OF SHGSIS BASED ON THE FOLLOWING PRINCIPLES

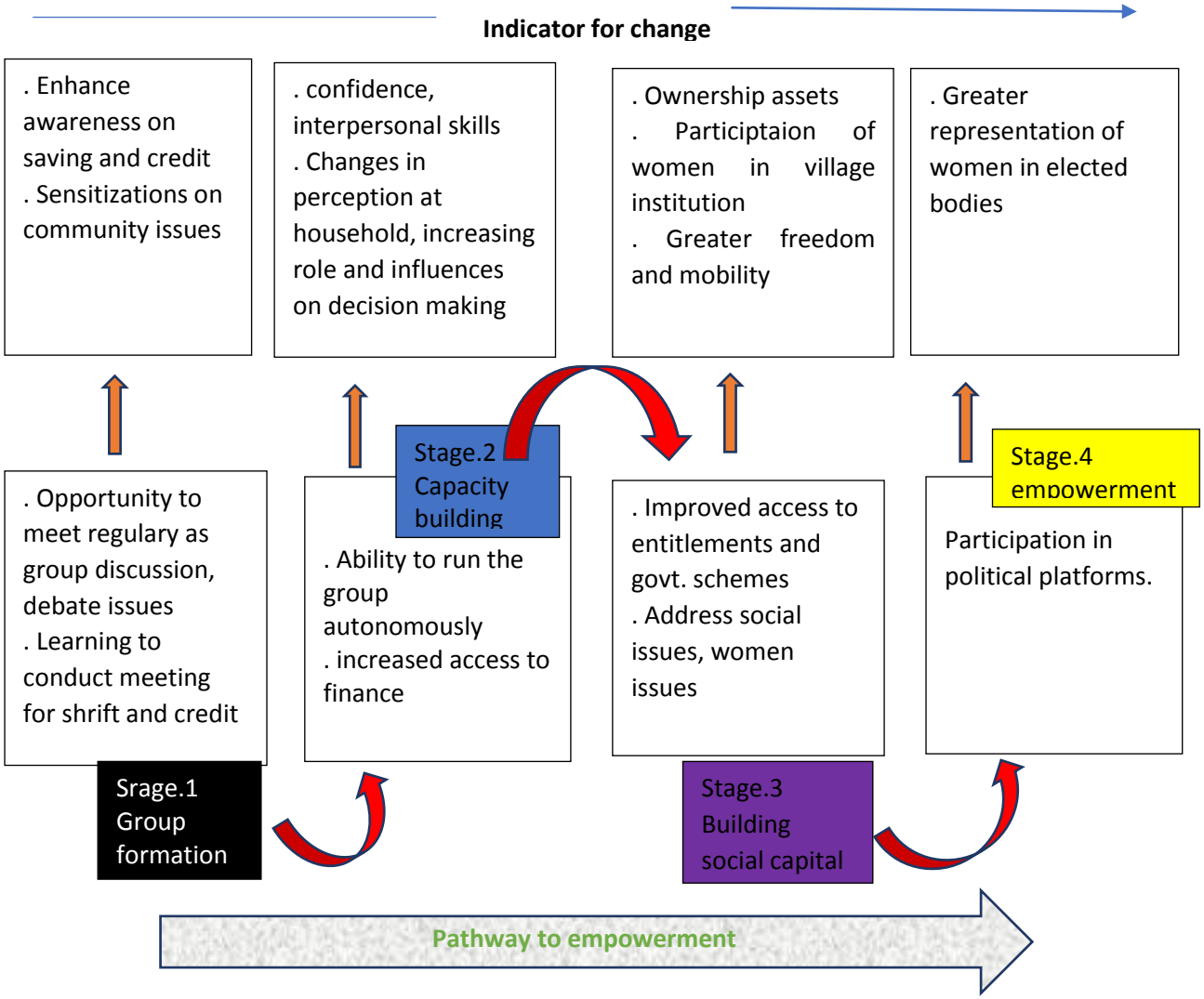
• Self-help supplemented with mutual help can be a powerful vehicle for the poor in their socioeconomic development;
• Participative financial services management is more responsive and efficient;
• Poor need not only credit support, but also savings and other services;
• Poor can save and are bankable and SHGs as clients, result in wider outreach, lower transaction cost and much lower risk costs for the banks;
• Creation of a common fund by contributing small savings on a regular basis;
• Flexible democratic system of working;
• Loaning is done mainly on trust with a bare documentation and without any security;
• Amounts loaned are small, frequent and for short duration;
• Defaults are rare mainly due to group pressure; and
• Periodic meetings non-traditional savings.

SHGs and Rural Development

In order to change the face of socio-economic scenario, micro enterprises and SHGs are playing significant role in the self-employment by raising the level of income and standard of living rural people. In this framework, one of the most vital aspects of rural self-employment is the formation of SHGs which is a valuable investment in human capital through training and capacity building measures. From dairy to mechanized farming, weaving, poultry, food processing units, mushroom cultivation;

Rural India has been busy setting up micro-enterprises by forming SHGs. The group members use collective wisdom and peer pressure to ensure appropriate use of fund and its timely repayment. These are informal groups in nature where members come together towards collective action for common cause. The common need is meeting their emergent economic needs without depending on external help. SHG movement is supposed to build economic self-reliance of rural poor, overcome misuse and create confidence predominantly among women who are mostly unseen in the social structure.

SHGs milestone for women empowerment



Stage I: SHG provides a new opportunity for women to come together, meet regularly, discuss, debate and exchange views on important common issues

Stage II: The emerging financial power through their association with SHG contributes to increase women's influence on household decision making

Stage III: Women start assuming a larger role in their communities like community work, monitoring and implementation of government programmes and schemes and participation in community meetings. They are now seen as active participants in village community

Stage IV: Women graduate from being participant in social and political platforms to a more empowered role where they could successfully contest elections, and assume political power

CONCLUSION

SHGs can play important role in achieving the long-cherished objectives of poverty alleviation and rural development through their diversified programmes. The formation of common interest groups has had a substantial impact on the lives of its member. Empowerment of women and the inculcation of financial training and discipline amongst the poor will undoubtedly have long term socio- economic benefits.it is unique system for poverty eradication involving poor women who work together in order to bring a positive shift in their socio- economic status. It can be hoped that the SHG programme could bring about radical change in the lives of the poor sections of the society in the years to come.

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Innovations for Climate: Resilient Agriculture

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INTRODUCTION

Climate is the primary determinant of agricultural productivity. Over the past few decades, the man-induced changes in the climate have intensified the risk of climate dependent crop production. The most imminent of the climatic change is the increase in the atmospheric temperature due to the increased levels of greenhouse gases GHGs in the atmosphere. It has manifested in terms of frequent occurrence and repetition of events like droughts, melting of glaciers and rising sea levels. These changes are already demonstrative causing serious threat to food security of the nation. Indian agriculture is highly prone to the risks due to climate change; especially to drought, because 2/3rd of the agricultural land in India is *rainfed*, and even the irrigated system is dependent on monsoon. Climate change can affect agriculture through their direct and indirect effects on the crops, soils, livestock and pests. Climate change also have considerable indirect effects on agricultural land use in India due to availability of irrigation water, frequency and intensity of inter- and intra-seasonal droughts and floods, soil organic matter transformations, soil erosion, changes in pest profiles, decline in arable areas due to submergence of coastal lands, and availability of energy.

Vulnerability of Indian Agriculture to Climatic Variability and Change:

Climate change denotes long term changes in climate including mean temperature and precipitation. Shifting weather patterns result in changing climate, which threatens food production through high and low temperature regimes, increased rainfall variability, rising sea levels that contaminate coastal freshwater reserves and increased risk of flooding. Last three decades saw a sharp rise in all India mean annual temperature. Analysis of data for the period 1901-2005 by IMD suggests that annual mean temperature for the country as a whole has risen to 0.51°C over the period. It may be mentioned that annual mean temperature has been consistently above normal (normal based on period, 1961-1990) since 1993. India is one of the most vulnerable countries in the world when it comes to climate change. According to estimates, India could witness a temperature rise of over 4°C by the last quarter of the century. The Intergovernmental Panel on Climate Change's (IPCC's) assessment report in 2014 says that both rice and wheat could see drops in yield by 7-10 per cent and in maize by up to

50 per cent by 2030. The need for adaptation to climatic exigencies has been starkly evident over the years.

Impact of Climate Change on Crop Productivity:

Climate change will have negative effects on irrigated crop yields across in India, due to temperature rise and changes in water availability, while rainfed agriculture will be primarily impacted due to rainfall variability and reduction in number of rainy day. The impact of climate change on agriculture is expected to be more severe than realized earlier, particularly in crops like wheat. Yield decline are likely to be caused by shortening of growing period, negative impacts on reproduction grain filling, decrease in water availability and poor verbalization. Biodiversity is also adversely affected which in turn affects agricultural production; this is particularly important to the marginal and small farmers in India. Low organic carbon, low biological activity and high level soil degradation are common features of dryland regions. Soils in drylands are not only thirsty but also hungry. Wide spread deficiencies of macro and micro nutrients occur due to loss of nutrients through surface soil erosion and inadequate nutrient application. The impacts of climate change are global, but countries like India are more vulnerable in view of the high population depending on agriculture. Agriculture contributes roughly 16% of India's GDP, a 4.5 to 9% negative impact on agricultural production implies a cost of climate change to be roughly up to 1.5% of GDP per year.

Climate Resilient Technologies for Indian Agriculture:

Potential adaptation strategies to deal with the impacts of climate change are developing cultivars tolerant to heat and salinity stress and resistant to flood and drought, modifying crop management practices, improving water management, adopting new farm techniques such as resource-conserving technologies, crop diversification, improving pest management, better weather forecasts and crop insurance and harnessing the indigenous technical knowledge of farmers . Some of these strategies are discussed below.

1. Climate-ready Crop Varieties: Development of new crop varieties with higher yield potential and resistant to multiple stresses (drought, flood, salinity) will be the key to maintain yield stability. It is essential to develop tolerance to multiple abiotic stresses as they occur in nature. Germplasm with greater oxidative stress tolerance may be exploited as oxidative stress tolerance, where plant's defence mechanism is targeting abiotic stresses.

2. Water-Saving Technologies: Efficient use of natural resources such as water is highly critical for adaptation to climate change. On-farm water conservation techniques, micro-irrigation systems for better water use efficiency and selection of appropriate crop need based irrigation has to be promoted. Principles of increasing water infiltration with improvement of soil aggregation, decreasing runoff with use of contours, ridges, vegetative hedges and reducing soil evaporation with use of crop residues mulch could be employed for better management of soil-water.

3. Integrated Farming: Integration should be made among crop production, livestock, agro-forestry and fish production to improve the production, income and livelihood. Major emphasis should be given on development of diverse technologies for optimization of farm resources, increased economic return, and improved sustainability in an integrated farming systems approach.

4. Improved Nutrient Management: The adverse impact of climate change on crop yield could be compensated with more and efficient use of plant nutrients. Improved nutrient management also offers promising opportunities for mitigating GHG emission. For example, technologies including matching N supply with crop demand, using proper fertilizer formulation and right method of application, use of N-transformation inhibitors, optimizing tillage, irrigation and drainage and growing of suitable crop cultivars are some of the potential technologies to reduce N_2O emission.

5. Conservation Agriculture: Conservation agriculture and resource conservation technologies (RCTs) have proved to be highly useful to enhance resource and or input-use efficiency. Yields of wheat in heat and water-stressed environments can be raised significantly by adopting the RCTs, which minimize unfavourable environmental impacts, especially in small and medium-scale farms. Zero-tillage can allow farmers to sow wheat sooner after rice harvest, so the crop heads and fills the grain before the onset of pre-monsoon hot weather.

CONCLUSION

Indian agriculture to the adverse impacts of climate change and making it more resilient. A win-win solution is to start with such adaptation strategies that are needed for sustainable development and also have mitigation co-benefits. There is a need to develop policy framework for implementing the adaptation and mitigation options so that the farmers are saved from the adverse impacts of climate change. Development of technologies for adaptation and mitigation and their uptake at speedy rate by the farmers are essential for climate change management. Development and operationalization of adaptation strategy necessitate socio-psychological empowerment of farmers besides developing competencies in acquiring knowledge and skills related to adaptation practices.

Importance of dehorning in dairy calves

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The process in which the horns of an animal are removed after birth by treating the tender horn roots with a chemical, mechanical or electrical dehorner. Dehorning of yearling and older animals is painful and results in considerable bleeding. Due to this reason the calves should be dehorned before 10 days old. Up to this age the horn button does not become attached to the skull. Many a times this practice is also called as disbudding as it involves the removal of horn buds and it is performed in initial stage of life. The removal of full-grownhorn is termed as dehorning.

Advantages:

The following are several advantages of dehorning. Such as;

- ✓ Safe handling and proper feeding of dairy animals.
- ✓ Protection of animals against injury due to fight.
- ✓ It is essential for any animals kept inloose housing.
- ✓ Uniform appearance of whole herd.
- ✓ Less floor space required per animal.
- ✓ Prevention against horn cancer.
- ✓ Cows and heifers can be fed in the sameshed.

Disadvantages:

However, there are certain disadvantages too;

- ✓ Animal with a nice horn have a style.This sometime is an advantage inexhibition and livestock fair & animal shows.
- ✓ Some breeds have got an importantidentification mark for horn e.g.,Kankrej, KangayamKhillar, Hallikaretc.
- ✓ Animals with horns can defend themselves during conflicts.

METHODS FOR DISBUDDING/ DEHORNING

The disbudding can be performed with following methods;

1. Chemical Method:

Materials required

1. Caustic stick (KOH) and holder
2. Scissors
3. Vaseline
4. Cotton wool
5. Dusting powder (ZnO)
6. Suitable bedding
7. Spirit

Procedure:

- ✓ Cast the animal down and secure itsfeet together with a rope.
- ✓ Turn the head slightly towards theoperator.
- ✓ Locate the horn bud.
- ✓ Clip the hair 2 cm around the horn bud.
- ✓ Rub the horn bud with a piece of cottonwool soaked in surgical spirit.
- ✓ Apply Vaseline in a ring shape aroundthe horn bud.
- ✓ Hold the caustic stick in the holder or with apiece of paper cotton and wet the tip.
- ✓ Rub it in a circular motion on the hornbud.
- ✓ Stop it as soon as the entire bud surfacebecomes reddish in appearance.
- ✓ Wipe the surface with cotton.
- ✓ Put some dusting powder.
- ✓ Repeat the same procedure with otherbud.

Precautions:

- ✓ If bleeding occurs, seal it with tincturebenzoin or Tincture Ferrous chloride.
- ✓ Calves should not be turned out intorain after the treatment with causticpotash to prevent spreading andburning tolarge area.
- ✓ Caustic potash stick should be previously wrapped in paper to avoid burning of operator's fingers.
- ✓ Optimum age of calf for dehorning is two weeks.

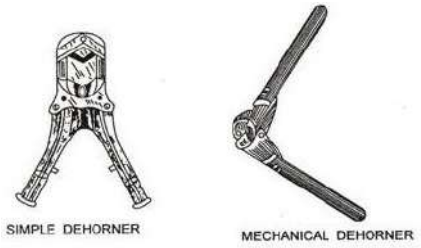
Substitute chemical for caustic potash:

Nowadays, dehorning paste used for destroying the horns matrix in calf hood. These often consist of sodium hydroxide to prevent horn growth. A widely used paste formula contains 52% sodium hydroxide, 14% calcium hydroxide and 44% water. Other chemicals such as Antimony tri-chloride and salicylic acid also used.

2. Mechanical Method:

Material required

1. Mechanical dehorning clippers(Dehorner, horn pincer and saw)
2. Bandages
3. Cotton wool
4. Spirit
5. Pine tar
6. Sulphanelamide powder and
7. Iodoform




Dehorning Saw

Procedure:

- ✓ Animal should be casted and thrown on the soft ground properly.
- ✓ When animals have partly or fully-grown horns, the hornpincers or clippers ordehorning saw isused to cut the horn.
- ✓ This operation shouldtake place when animal is around 2 years ofage or older.
- ✓ The wound should be coveredwith sulphanelamide powder mixed withiodoform or it should be treated with pine tar orcotton soaked in pine tar then applybandages.

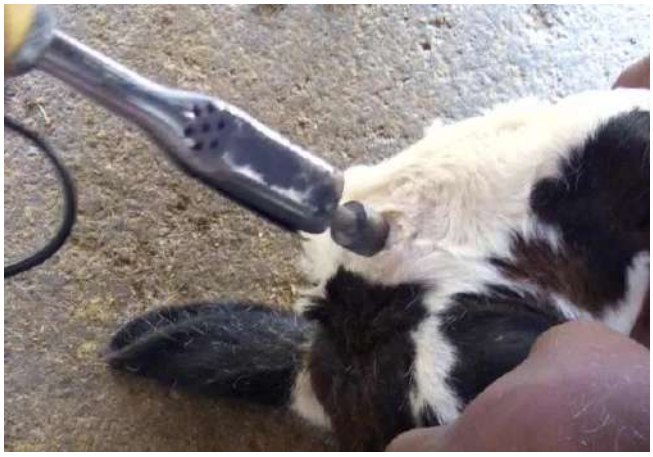
Precautions:

- ✓ Whichever the instrument is used, hornshould be removed as near the head aspossible.
- ✓ If dehorning is done in hot and rainyweather, care must be taken to protectthewound from flies.Iodoform may beused as fly repellent. Preferably, it should be performed in cold weather.
- ✓ This method should not be used at anearly age, as the scars are likely todevelop.
- ✓ To minimize the bleeding, the hornartery may be tied with a silk thread.
- ✓ Aseptic measures should be followed.

3. Electrical Method:

Material required

1. Electrical dehorner
2. Scissors



Procedure:

- ✓ Secure the calf of 3 weeks age on proper bedding gently.
- ✓ Locate the horn buds properly.
- ✓ Clip the hairs 2 cm around the horn buds.
- ✓ Switch on the current to make end of the electric dehorner red hot (Temperature 673 °C or 1000 °F).
- ✓ The horn is cauterized by applying electric dehorner just for 8 to 10 seconds.
- ✓ The calf is let loose when golden color appears at the site of cauterized horn buds.
- ✓ If electric dehorner is used properly the calf never bleeds and the method is quitesafe and quick.

4. Rubber Band Method:

Material required

1. Tight rubber rings
2. Scalpel
3. Elastrator

Procedure:

- ✓ Secure the calf in which horns are very small and not hard.
- ✓ Turn the calf head slightly towards the operator.
- ✓ Make a shallow groove around the base of horn forming ring.
- ✓ Slip a tight rubber ring over the horn with the help of elastrator and fix it into the grove.

- ✓ After few days the horn will gradually get out and fall on the ground because the tight rubber ring will shut off the blood supply to the horn.
- ✓ However, it is not adependable and satisfactory method.

CONCLUSION:

The above mentioned are suitable and easily operated procedure for the disbudding or dehorning of the dairy animals. The dairy farmers should implement this for the efficient dairy herd management.

Chitinase: A novel biopesticide for insect and nematode pest management

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Abstract:
Chitin is second most abundant biopolymer in the universe. Chitinase is produced by a variety of microorganism (Bacteria, virus and fungi) and plants. The chitinases can be used as a biopesticide as they are not harmful to plants and vertebrates. These chitinases were proved to have insecticidal activity against many lepidopteran larva and coleopteran pest. It also exhibit synergistic activity against Bt CRY proteins. Further some fungal chitinases has nematicidal activity. In recent research developments were made to produce Bt conjugates with chitinae to synergise the Bt CRY activity. Some of the Fungus like *Purpureocillium lilacinum* and *Pochonia chlamydosporia* exhibit ovicidal activity against plant parasitic nematodes. Hence there is ambient scope for developing chitinase as a viable biopesticide once its shelf life and storability has been extended.

Key words: chitinase, insect biopesticide, organic nematicide, chitinolytic bacteria

INTRODUCTION:

Chitin is the second most abundant biopolymer in the world that stands next to cellulose. It is an insoluble linear homopolymer of N-acetylglucosamine (GlcNAc) residues linked by β-(1,4)-glycosidic bonds. It is the building block of cell wall of many fungi, some algae, cyst of some protozoans, Molluscs, egg shell of nematodes, insect cuticle and peritrophic membrane lining of the midgut epithelium in insects. The insect pests (gram pod borer, spotted pod borer, pod bug, pod fly, etc.) and plant parasitic nematodes (root knot nematode, leison nematode, etc.) inflict huge yield loss in agricultural crops.

The chitinases (EC 3.2.1.14) belongs to family 18, 19 and 20 glycosyl hydrolases (GH). The chitinase are diverse protein encompassing a molecular mass from 14 to 150 kDa, optimal temperature from 18 to 90°C and a pH of 1 to 10.5. Chitinases are hydrolytic enzymes produced by a variety of biocontrol agents (BCAs) like *Serratia marcescens*, *B. thuringiensis*, *Trichoderma* sp., baculoviruses, etc. Majority of the

reported chitinases were produced by bacteria belonging to actinobacteria, firmicutes, γ proteobacteria and sphingobacteria followed by fungi.

Chitinolytic bacteria comprise only 4% of total heterotrophic bacteria. Most of the bacterial chitinases fall under GH 18 family except those from actinomycetes (*Streptomyces griseus* IIUT 6037) and purple bacteria which fall under GH19 family. Bacterial chitinases have a molecular weight of 20-60 kDa and they are smaller than insect chitinases (40-85 kDa) while similar to that of plant chitinases (40-85 kDa). Endochitinase from *Streptomyces violaceusniger* and thermostable chitinase from *Streptomyces thermoviolaceus* OPC-520 have an optimum temperature of, respectively, 28°C and 80°C. The latter enzyme has high pH optima in the range of 8.0 to 10.075, while the chitinase isolated from *Stenotrophomonas maltophilia* C3 has pH optima in the range of 4.5 to 5.0. Bacterial chitinases also show a broad range of isoelectric points (pI 4.5-8.5). The chitinolytic bacteria produce three types of enzymes viz., exo-chitinases, endo-chitinases and N-acetyl glucosaminidases. The presence of endo-chitinases increases the substrate availability for exo-chitinases and N-acetyl glucosaminidases for a co-operative degradation. The majority of chitinases posse's chitin binding molecules (CBM) and theses CBMs are classified into 64 families based on amino acid similarity in CAZy (Carbohydrate-Active enZYmes) database. It also plays pivotal role in ligand recognition and binding, and efficient substrate hydrolysis.

Bacterial chitinases as biopesticide:

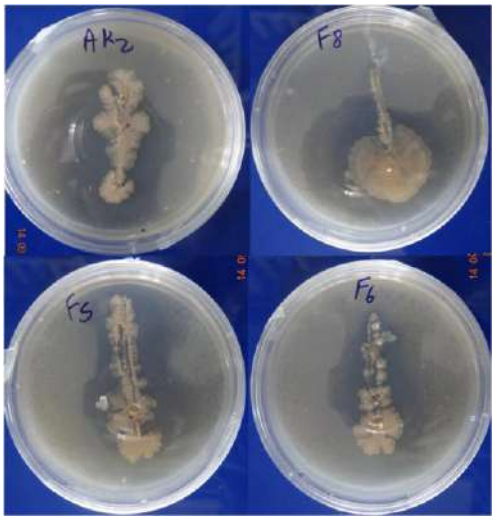
Insects:

The chitinases from various micro organisms were proved to be insecticidal by various workers. For example, *S. marcescens* produces 3 chitinases, a chitobiose and a chitin binding protein. Three chitinases (ChiA to ChiC) from *S. marcescens* WW4 had proved toxic to lackey moth, *Malacosama neustria* and pod borer, *H. armigera* larva. A talc based formulation of γ-proteobacteria, *Pseudomonas fluroescens* along with chitin is reported to reduce leaf folder, *Cnaphlocrocis medinalis* incidence in rice by 56.1% (Commare *et al*., 2002). Chitinase from *Pseudomonas fluroescens* MP-13 showed toxicity against tea mosquito bug, *Helopeltis theivora*. Chitinolytic strains of *Bt* showed increased toxicity than their non-chitinolytic strains. Purified chitinase from *B. subtilis* hampered the development of tobacco caterpillar, *S. litura*. Similarly, chitinases from *B. laterosporus* Lak 1210 showed insecticidal activity against diamond back moth (DBM), *P. xylostella*. *Yersinia entomophaga* MH 96 produces a toxin complex Yen-Tc wherein two endochitinase genes *viz*., Chi1 & Chi2 (60 & 70 kDa) are responsible for insect toxicity against coleopteran (grass grub, redheaded pasture cockchafer and black headed pasture cockchafer) and lepidopteran insects (DBM).

Regev *et al*. (2006) demonstrated that endochitinase (ChiAII) from *S. marcescens* and Cry 1C from *Bt* had a synergistic effect against *S. littoralis* larva by reducing its weight gain to the tune of 62.0 to 98.2%; while the Cry 1C alone had caused 37% larval weight reduction only. They also demonstrated that perforations made in peritrophic membrane are responsible for the synergistic reaction between chitinase and cry. The chitinase co-administration with CRY proteins results in lowering of the

LC_{50} values in *H. armigera* and *S. exigua*. In order to improve the efficacy of *Bt* strain against greater wax moth, *Galleria mellonella* and *Drosophilla melanogaster* adult. Arora *et al*. (2003) also reported a synergistic action of *chi* and *vip* from *B.t.kurstaki* HD1. Ozgen *et al*. (2015) cloned ChiB and ChiC of *S. marcescens* Xd1 into *Bt*. In another report chitinase from *B. circulans* no. 4.1 is cloned into *B.t.aizawi* and it showed 27% higher toxicity against gypsy moth, *Lymantria dispar*. Similarly recombinant *B.t.aizawi* carrying *ChiBIA* from *B. licheniformis* has showed 20% higher mortality in *S. exigua* larva. These studies confirm the chitinase as a potential synergist for CRY proteins. A transgenic tomato harbouring chitinase gene from *Streptomyces albidoflavus* is found to incorporate resistance against cabbage semi looper, *Trichoplusia ni*. In ICAR-IIPR we had isolated a Bt producing chitinase that is possessing high insecticidal activity against Bihar hairy caterpillar, *Spilosoma obliqua*, *H. armigera*, *Olepa ricini* and other lepidopterans (Fig.1.).

Fig.1. Chitinolytic Bt strains growing in chitin media showing chitinase production.



Nematode:

Chitinolytic bacteria producing protease, siderophore and secondary metabolites were found superior for nematode management. For example, *B. pumilus* L1 produces both protease and chitinase which inturn had inhibited egg hatching and mortality in *Melidogyne arenaria*, J2 Juvenile stage. Similar effect was reported in *Pseudomonas chitinolytica* against *M. javanica*. *Corynebacterium paurometabolu* inhibited nematode egg hatching by producing hydrogen sulphide and chitinase. The lytic enzyme system of *Lysobacter capsici* YS1215, the chitinase and gelatinase played an important role in suppression of *M. incognita* infection in tomato. Chitinases alone or in combination with other defense related substances are responsible to bring out these nematicidal properties in different plants. Incase of rice various defence related enzymes (phenol, peroxidase, polyphenol oxidase, phenyl ammonia lyase, super oxide dismutase) were induced along with chitinases in rice root tissues by *P. fluorescens* against *M. graminicola* (Anita and Samiyappan, 2012). Similarly in groundnut, treatment with chitinolytic *P. fluorescens* resulted in accumulation of phenols, peroxidase and chitinase in pea nut leaf concurrent reduction of gall numbers by *M. arenaria*.

Viral chitinase:

Among the baculovirus AcMNPV has found to have ChiA that promotes liquefaction of insect host and is reported to have both exo and endo chitinolytic activity and is active across a pH range of 4 to 10. Another baculovirus known to posses chitinase is DkChi (*Dendrolimus kikuchii* NPV) that has showed mortality against *H. armigera*, *S. exigua*, *Hyphatria cunea* and *L. dispar*.

Fungal chitinase:

The role of fungal chitinases in insect cuticle penetration by the entomopathogenic fungi such as *Metarhizium*, *Beauveria*, *Isaria*, and *Trichoderma* is well established. Chitinases were also widely investigated as a component of that set of hydrolytic enzymes (namely, proteases, chitinases, and collagenases) that are secreted by nematophagous fungi (*Pochonia* spp., *Arthrobotrys* spp., and *Paecilomyces* spp.) when they attack living nematodes. In the 1980s, studies aimed at screening isolates for ovicidal soil fungi demonstrated for the first time a correlation between the chitinolytic activity of fungi and their ability to parasitize nematode eggs. The culture filtrates of *Purpureocillium lilacinum* strain 251 has been reported to have 6 proteins with chitinolytic activity as well as statins. The chitinase along with serine protease from the same fungus has resulted in 79% reduction in egg hatching in *M. javanica* eggs. In particular, Dackman et al. (1989) found that two isolates of *Verticillium* spp. efficiently parasitized eggs of *Heterodera schachtii* owing to their high chitinase and protease activity. From two distinct *Verticillium* species (*Pochonia chlamydosporia,* synonym *V. chlamydosporium*, and *Metapochonia suchlasporia*, synonym *V. suchlasporium*) a chitinase named Chi43 was purified and characterized by Tikhonov et al. (2002). Scanning electron microscopy analyses confirmed the nematicidal action of these *Verticillium* chitinases: indeed, the proteins were able to induce scars on the surface of *Globodera pallida* eggs. Damaging effects were even more pronounced when the sample was treated with Chi43 in association with P32, a serine protease that was secreted by the fungus during infection (Tikhonov et al., 2002). In ICAR-IIPR the chitinase producing *Trichoderma* sp and *Purpureocillium lilacinum* strains were identified and characterized (Fig.2.).

Fig.2. *Trichoderma sp* and *Purpureocillium lilacinum* strains showing chitinase production.

CONCLUSION

The chitinases are a potential biopesticide against insect pest and nematodes. Concurrently they are safe to plants and vertebrates. Hence it can be deployed as a

ecofriendly biopesticide. There is a wide scope for enhancing the efficacy of convential insecticidal toxins like CRY & VIP by chitinases. Even though wide variety of organisms like bacteria, fungi and virus produce chitinase only bacterial chitinases are studied in depth. The native chitin is always associated with proteins, pigments and other elements. The association of other additional enzymes like proteases, glucanases support or even synergize chitinases activity to improve pathogenicity and biocontrol efficacy. Therefore, a thorough understanding of production of secondary metabolites offers potential for efficient utilization of chitinolytic bacteria in pest management programs. Additionally, the extracellular chitinase production is also influenced by media components such as carbon sources, nitrogen sources, salts, amino acid analogues and agricultural residues. Still more intensive research towards extracellular production of chitinase as biopesticide is needed so that the chitinases can be produced at commercial level. The demand for chitinase as biopesticide will be increased if researchers had find ways for extending the shelf life, easy delivery mechanism in field and easy storability with non optimal conditions (humidity, temperature and light).

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Biochar – A Potential Tool for Soil Remediation

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Soil degradation and soil contamination are increasing at an alarming rate and assuming prominent concern as they would contribute to secondary environmentaland ecological problems viz. land productivity decline, food security and even climate change.Contamination of soils with both organic and inorganic pollutants is a globally recognized issue and this situation calls for development of environmentally safe and economically viable remediation strategies. Huge areas of fallow and cultivable lands are prone to contamination, the major contributors being acid mine drainage, industrial wastewater, mine tailings, waste rock piles and sewage sludge leading to deterioration of soil and water quality. Toxic metals could accumulate in agricultural soils and get into the food chain, which would pose a major threat to food security.High concentrations of toxic elements, organic contaminants, acidic soils and harsh climatic conditions restrict re-establishment of vegetation.

Biochar, the solid product of pyrolysis producedthrough heating of biomass at 300 to 500°C in absence of oxygen, that contains stable aromatic organic matter with carbon concentrations of about 70to 80% and mineral matterincluding nutrients, is gaining importance as a soil remediation tool. Biochar has notable properties that make it appropriate for the remediation of contaminated soils viz. high surface area,higher porosity, variable charge, and functional groupsthat can increase soil water-holding capacity, pH, cation exchange capacity (CEC), surface sorption capacity, base saturation and crop resistanceto diseases when added to soil.The threedimensional reticulated and porous structure of biochar, could contribute to a long-term storage of carbonand the adsorption and degradation of pollutants.Biochar also offers resistance to soil degradation. Generally, pyrolysis temperature bears a direct correlation with the surface area of biochar;higher the temperature at which the organic material is pyrolyzed, the higher the surface area of the resulting biochar. There is a considerable negative charge over the surface of biochar which attracts positively charged metals and organic compounds to the internal biochar surface from the soil solution.

Biochar enhances seed emergence, soil and crop productivity, above ground biomass, and vegetation cover on mine tailings, waste rock piles, and industrial and sewage-wastecontaminated soils by elevating levels of soil nutrients and water-holding

capacity, amelioration of soil acidity and stimulation of microbial diversity and functions.

Biochar due to its excellent adsorption capacities alone or in combination with organic compost, has a promising prospect in industrial applications and environmental remediation, including waste water and water treatment, and restoration and revegetation of mine tailings. Remediation and rehabilitation of these contaminated soil and perilous waste can be achieved by phyto-stabilization, a long-term and cost-effective rehabilitation strategy, through promoting the revegetation to reduce the risk of pollutant transfer and ecological restoration.Application of biochar to contaminated soil and waste rock piles may increase soil pH, water holding capacity and soil fertility, reduce the mobility of plant-available pollutantsand promote revegetation. Biochar can remediate soil contaminated with both heavy metal and organic pollutants such as polycyclic aromatic hydrocarbons (PAHs) and tertbutyl azine (herbicides for vegetation management through electrostatic interaction and precipitation of heavy metals, and the surface adsorption, partition and sequestration of organic contaminants.

Success in restoration and reclamation is dependent onthe physico-chemical soil characteristics and soil community complexity. Soil amendments by compost,biochar and arbuscular mycorrhizal fungi may facilitate grassland recovery in severely degraded habitatsand the promotion of grassland ecosystem sustainability. Biochar has potentialimpacts on restoration of degraded and contaminatedland. Biochar amendment has significantlyimproved root traits, particularly root mass density androot length density, enhanced root establishment incontaminated soils, and reduced Cu uptake by plantscompared to unamended soil. Many researchers have demonstrated the potential of biochar as a low-cost adsorbent, storing chemical compounds including some of the most common pollutants such asheavy metals, pesticides or herbicides. Itcould be regarded as an environment friendly and carbon-neutral material, as thebiomass releases the same quantity of CO_2into the atmosphere during the conversion and utilization as thatabsorbed by the photosynthesis during its growth.

Soil salinization and sodificationassume significance as majorthreats to soil productivity in arable lands.In-order to attain expansion of cultivable area and curtail the risk of globalfood security, conversion of barren salt affected lands to cultivable lands assumes significance. Studies conducted by various scientists revealed that biochar application to salt-affected soils to a large extent aided in alleviating salt stress and improved plant growth directly through the release of essential macro (N, P, K, Ca) and micro (Cu, Zn) nutrients in soil to helpoffset the adverse impacts of salts.

CONCLUSION

Biochar as an amendment can serve the purpose of nourishing and restoring soils contaminated at varying degrees through diversified sources and conditions, hence emphasis to be laid towards developing comprehensive and concerted research which would provision exploring various possibilities of utilizing biochar for soil health enhancement.

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Diversification of beekeeping for increasing income of farmers

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Bee keeping holds immense scope for increasing productivity due to cross pollination and generation of income through employment and diversification of hive products. Due to this immense potential, it was thought pertinent to revive the beekeeping activities in the country. At present Punjab, Uttar Pradesh, Bihar, Orissa, Haryana, Andhra Pradesh, Karnataka and Tamil Nadu produce sizeable quantity of honey. The awareness of organic farming and pesticide free environment has made Indian farmers to adopt crop production technologies that make the crop environment free of pesticides. The All India Coordinated Project (AICRP) on Honey bees and Pollinators under ICAR and State Agricultural Universities play a major role in conducting research work for improving livelihood of Indian beekeepers and farmers. The National Bee Board of Government of India, and Khadi and Village Industries Commission under the Ministry of MSME also have a role in improving honey production in India.

Role of beekeeping in increasing income of farmers

Besides honey production, bee keeping helps farmers through pollination services and through value addition to the hive products so that these products are sold at good rates in the market and thus help farmers generate extra income and help in sustainability of livelihood for farmers.

Pollination services

Pollination is an essential agro-ecosystem service, as it enables plant reproduction and food production for humans (fruits and seeds) that depend, to a large extent, on the symbiosis between species, i.e., the pollinated and the pollinator. The reduction and/or loss of either will affect the survival of both. Pollinators contribute to the maintenance of biodiversity, and ensure the survival of plant species including crops that form the basis of agriculture and food security to innumerable rural households. Of the hundred or so insect pollinated crops which make up most of the food supply, 15% are pollinated by domestic bees, while at least 80% are pollinated by wild bee species and other wildlife. Diversity among species, including agricultural crops, depends on the insect pollination. Approximately 73% of the cultivated crops, such as apples, mangoes, cashews, squash, and oil seeds are pollinated by some variety of bees, 19% by flies,

6.5% by bats, 5% by wasps, 5% by beetles, 4% by birds, and 4% by butterflies and moths. Of the principal crops that make up most of the food supply, only 15% are pollinated by domestic bees (mostly honey bees, bumble bees and alfalfa leafcutter bees), while at least 80% are pollinated by wild bees and other wildlife (globally there are an estimated 25,000 bee species, the total number of pollinators probably exceeds 40,000 species). Services that are provided by native pollinators (non-honeybee species) is significant to agriculture. Even though the contribution of pollinators to annual agriculture productivity in India is yet to be assessed, the value of the annual global contribution of pollinators to the major pollinator-dependant crops is estimated to exceed US$ 54 billion. Therefore, Pollinator management and conservation requires a nationwide initiative (in the form of AICRP-ICAR). The priority for the maintenance of ecosystem services dependent on pollination and pollinators is important for the sustainability of agriculture. The need to address the issue of declining pollinator diversity calls for a national Initiative, like the one being proposed, on the Conservation and Sustainable Use of Pollinators. Honeybees are not the only "manageable" pollinators. Use of a single species to obtain improved production in a diversity of crops will not work always. Stingless bees, leafcutter bees, bumble bees are also suited for planned pollination in crops. Wild pollinators are not only important for improving the productivity of agricultural crops but also for maintaining the reproductive viability of native plants, including wild relatives of crop species.

Paid pollination services to double income of farmers

The farmers in many regions pay the bee keepers to place their bee hives in close vicinity of their fields so that cross pollination is assisted in which in turn helps farmers in increasing their yield and the bees get plenty of nectar source in return. In Himachal Pradesh, India this practice has already started and is likely to be followed in other states as the awareness about pollination benefits is realized by the farming community. Evidently to ensure the country's self-sufficiency in foodstuffs, to receive foreign currency from excess production, the stabilization of rural populations by complementary activities of both a financially rewarding and environmental nature, and there is no doubt that beekeeping fits perfectly within this framework and hence, efforts are required to popularize and increase beekeeping still an enormous potential waiting to be tapped.

Honeybee pollination is essential for some crops, while for others it raises yield and quality. In addition to the crops, a wide range of pastures, including Lucerne and clover, are pollinated by honeybees hence this estimate understated the potential value of the pollination services. Beekeeping also increases production of fruit and vegetables, particularly cross pollinated crops such as cabbages, cauliflowers, carrots, turnips, radishes, and other vegetables.

Scope of hive products like pollen/royal jelly capsules/proposlis/wax candles to double farmers income

Beeswax: Beeswax is a substance secreted by the worker bees. It is recovered by beekeepers primarily from honey comb cappings, and also from cull combs and wax

pieces. Beeswax is used in certain pharmaceutical and ointments, for candles – and for comb foundation for beekeeping. It has the highest melting point of natural waxes, and can be sold in either the raw or refined form. Commercial beeswax is generally refined for sale by a manufacturer of apiary products. At least small quantities will always be needed to maintain quality and specific characteristics. Similar trend in the pricing of beeswax and its products is noticed as sen in honey, it varies from region to region and country to country. It is used in candle making, skin creams, grafting wax for horticulture, polishes and varnishes, paste furniture polish, liquid furniture polish, spary polish, floor polish, shoe polish, cream type. cravons, leather preserves, waterproofing textiles and paper, paint, wood preservative, sarm lure, veterinary wound cream, adhesive lotions.

Live bees: The production of queen bees, and of entire colonies of bees, it the main diversification available to beekeepers. The queen bee industry is dependent on the existence of a profitable honey industry and on an export market to buy queens at a period when little or no sales. Package bees and nucleus colonies are other forms of live bee production, and are sold both within the country and overseas. Again, data on total value of production for this sector of the industry is not available, and has been estimated on the basis of known production. The total value of this sector has been assumed to be $2.25 million, which is almost certainly, and under-estimate, but which has been used as a conservative minimum. In India where great potential of beekeeping exists marketing for live bees can be much more.

Other products: In addition to honey and wax, active beehives are also a source of other products. These include:

Royal Jelly: A milky white smooth jelly secreted by nurse bees, used to feed developing queen larvae and young worker bee larvae. The production of royal jelly is a very specialized procedure, and flora conditions must be ideal before production can be considered. Royal jelly is used as tablets, or mixed into creams and shampoos. Royal Jelly can be sold in its fresh state, unprocessed except for being frozen or cooled, mixed with other products, or freeze-dried for further use in other preparations. The fresh production and sale can be handled by enterprises of all sizes since no special technology is required. In its unprocessed form it can also be included directly in many food and dietary supplements as well as medicine-like products or cosmetics.

As dietary supplement: Royal jelly belongs to a group of products generically described as “dietary supplements”. These are products which are consumed not for their caloric content nor for pleasure, but to supplement the normal diet with substances in which it might be laking.

As ingredient in food products: A mixture of royal jelly in honey (1-3% royal jelly) is probably the most common way in which royal jelly is used as a food ingredient. Among the advantages of this product are that no special technology is required and the honey masks any visible changes in the royal jelly. The final product is pleasant-tasting and it provides the beneficial effects of both products.

As ingredient in medicine-like products: In medicine-like formulations royal jelly is generally included for its stimulatory effects. However, it is also used to solve specific

health problems. A variety of formulations are available, often containing ingredients otherwise used to alleviate particular afflictions or as medicine.

As ingredient in cosmetics: Except in Asia, probably the largest use of royal jelly is in cosmetics. Royal jelly is included in many dermatological preparations, but mostly in those used for skin refreshing, and skin regeneration or rejuvenation. It is also used in creams or ointments for healing burns and other wounds.

Others: The only other known uses for royal jelly are in animal nutrition. In particular, royal jelly has occasionally been used (fresh or freeze-dried) to stimulate race horse. For experimental purposes it is also used as a food for rearing mites and insects.

Royal Jelly collection: Royal jelly is produced by stimulating colonies to produce queen bees outside the conditions in which they would naturally do so (swarming and queen replacement). It requires very little investment but is only possible with movable comb hives.

Propolis: A by-product of the bee hive. It originates as a gum secretion gathered by bees from a variety of plants, and can vary in colour depending on the plant species of origin. Propolis has remarkable therapeutic qualities, and is much sought after in some countries for the treatment of a range of human ailments, and for cosmetic purposes. It is used by honey bees as an antiseptic to varnish the interior of honey comb cells used by the winter chill, and for general hive cleanliness purposes. The market for raw material and secondary products containing propolis will probably continue to grow as they find more acceptance in medicinal uses and as more acceptance in medicinal uses and as more cosmetic manufacturers realize their benefits and marketing value.

Bee venom: Collected by stimulating bees with a mild electric current. The venom is processed, and used in the preparation of pharmaceutical materials. It can be used to detect hypersensitivity or allergic reaction to bee stings. The main venom producer is the USA which has produced only about 3kg of dry venom during the last 30 years (Mraz, 1982) but there is a large producer in Brazil and more or less significant amounts are produced in many other countries. Prices in 1990 varied greatly between US$100 and US$200 per gram of dry venom (Schmidt and Buchmann 1992).

Pollen: Pollen can also be harvested by beekeepers, at a rate of around 7-10 kg per hive per year. Pollen is used by bee colonies as a source of protein, but harvesting pollen by the beekeeper requires detailed knowledge of resources, hive management, species flowering variations and timing, and hive response to different honeys and pollens. Pollen is collected via specialized traps fitted to the hives, and must be processed rapidly after collection (usually via freezing or drying) to avoid excessive moisture absorption and fermentation. Many beekeepers harvest pollen to feed back to their hives during periods of natural pollen deficiency.

Most of the buyers and large scale sellers of pollen are also honey traders. Crane (1984) however, reports that a lot of commercial pollen is not bee collected, but machine-collected from certain wind pollinated plants which release very large quantities of dry pollen.

CONCLUSION

For rural/tribals/forest based populations, bee keeping is a great source of livelihood. Minimum funds are required to start this business even by unemployed youth. The natural resources of the flower like nectar and pollen are efficiently utilised by bees. It not only encourages ecological awareness but also helps in the promotion of rural and small scale industry which would eventually help in increasing the income of farmers by supplementing in agriculture.

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TILLING: An efficient reverse genetics approach for elucidation of gene functions in plants

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Abstract

Recent advances in large-scale genome sequencing projects have resulted in an upsurge in genome sequence information and has opened up new avenues for the application of mutations in basic technique as well as crop improvement. TILLING (Targeting Induced Local Lesions IN Genomes) is a non-GMO, cost-effective and less technically demanding, reverse genetics approach that can be efficiently used in functional genomics. TILLING combines benefits of high frequency mutations induced by classical mutagenesis, sequence availability and high-throughput screening methods for uncovering nucleotide polymorphisms in a targeted sequence. The variants of TILLING like Eco-TILLING and iTILLING have been developed to address the shortcomings of TILLING like non-amenability of few species to mutation and reducing the time duration in TILLING protocol respectively.

Key words: Eco-TILLING, iTILLING, Reverse genetics, TILLING

INTRODUCTION

One of the best approaches for elucidating gene functions is to mutate a specific gene, identify the mutation and then study the changes in phenotype of the mutated organism. Recently, advances in large-scale genome sequencing projects have resulted in an upsurge in genome sequence information and has opened up new avenues for the application of mutations in basic technique as well as crop improvement. In this regard, reverse genetics approach which involves mutation/alteration in the structure or activity of a gene followed by analysis of corresponding change in phenotype has emerged as an effective strategy for detecting gene functions. Different reverse genetics technologies proposed for functional genomics include insertional mutagenesis with T DNA, transposon/retrotransposon tagging or gene silencing using RNA interference (Bolle et al. 2011). However, their utilization is often limited by the requirement of

genome sequence information along with other technical drawbacks like creation of transgenic material, the development of which is not always feasible for many plant or animal species.

As an alternative to insertional mutagenesis and as a result of frustration of a graduate student TILLING (Targeting Induced Local Lesions IN Genomes) was developed in *Arabidopsis thaliana* (McCallum et al. 2000). TILLING derives benefit from high frequency mutations induced by classical mutagenesis, sequence availability and high-throughput screening for nucleotide polymorphisms in a targeted sequence. The general protocol for TILLING involves three steps, the first step is creation of mutant populations for which chemical mutagens preferably alkylating agents like Ethyl Methane Sulfonate (EMS), N-methyl-N-nitrosourea (MNU) and N-ethyl-Nnitrosourea (ENU) are used. Both EMS and MNU alkylates guanine bases and leads to mispairing: alkylated guanine pairs with thymine, which results mainly in G/C to A/T transitions whereas, ENU induces both transitions and transversions (G/C to C/G and A/T to C/G). Apart from chemical mutagens recent functional genomics approaches have also witnessed the use of physical mutagens like gamma-ray irradiation and fast neutrons. Creation of mutant population is followed by development of M_1 and M_2 generations and DNA extraction from individual M_2 plants. Further, DNA pools of 5-8 M_2 plants are created simultaneously with setting up of an M_3 seed bank.

The next step in TILLING protocol is detection of mutations in a targeted sequence. The first strategy that was described by McCallum et al. (2000) for detection of mutation involved use of pooled DNA from M_2 plants as a template for PCR amplification of the fragment of interest, formation of heteroduplex and the identification of heteroduplexes using denaturing HPLC (DHPLC). However, over time, this method, in most cases has been replaced by the digestion of heteroduplexes using mismatch-specific endonucleases like CEL I from celery and ENDO I from *A. thaliana* followed by polyacrylamide electrophoresis and visualisation in the very sensitive LI-COR gel analyser system (LI-COR Biosciences), which is less expensive and faster than DHPLC. CEL I recognize a mismatch and cleaves exactly at the 3′ side of the mismatch. Cutting by CEL I followed by denaturing gel electrophoresis can precisely identify base position of a mismatch. Once the location of a mismatch is determined, the base change can be inferred, since EMS produces mainly C/G to T/A transition mutations thus, making sequencing during discovery unnecessary and reducing the time and effort required to identify the individuals with desirable mutations. Once, the mutation in a specific gene is detected the individual plant (M_2) carrying the mutation is identified and further, the target gene segment is sequenced and type of nucleotide change is determined. The final step in TILLING protocol is analysis of the mutant phenotype for this, M_2 population is phenotyped and large M_3 population is generated for forward screening.

Bioinformatic tools in TILLING

One of the advantages in using TILLING approach is that, for analysing a species its whole genome information is not required. Different databases like GenBank http://www.ncbi.nlm.nih.gov/genbank/) can be used to retrieve sequence information of the gene of interest and then a proper homologue may be identified. The advancement in bioinformatics tools have boosted the use of TILLING strategy as an efficient reverse genetics approach. One of the crucial steps for TILLING analysis is the determination of an amplicon as selecting a suitable amplicon (preferably within the coding region) increases the likelihood of identifying such alterations in the DNA sequence which can have impact on the protein function. Next important task is identification of the most potential region that can generate deleterious changes. This can be achieved by using web-based program CODDLE (Codons Optimized to Detect Deleterious LEsions, http://www.proweb.org/coddle) developed by Nicholas Taylor and Elizabeth Greene for analysis of polymorphism and designing primers for any organism and any mutagen. CODDLE performs BLAST alignment in order to identify a conserved region, uses SIFT (Sort Intolerant From Tolerant) and PSSM (Position-Specific Scoring Matrix). Each of the identified alleles is then analysed in terms of changes in protein. PARSESNP (Project Aligned Related Sequences) is a bioinformatic tool designed for analysing nucleotide polymorphisms and evaluating SNPs. It also determines the effect of single nucleotide polymorphisms (SNPs) on protein, based on the alignment of related proteins with the use of PSSM and SIFT. The final step of TILLING is the phenotypic evaluation of plants carrying mutations, however, using bioinformatic tools like SAS (Sequence Annotated by Structure; http://www.ebi.ac.uk/thornton-srv/ databases/sas/) and SOPMA (Self- OPtimized Method for secondary structure prediction with Alignment), the putative effect of mutation on the secondary structure of proteins can be predicted beforehand which can then be verified experimentally by phenotyping each mutant.

ADVANTAGES OF TILLING OVER OTHER REVERSE GENETICS APPROACHES

The major advantage of TILLING over other reverse genetics strategies is that it can be applied to any plant species, irrespective of genome size, ploidy level or method of propagation. Additionally, in contrast to insertional mutagenesis, the TILLING strategy is general, because chemical mutagenesis can successfully be applied to almost all the major taxa. Another great advantage of TILLING technology is that it relies on the suitability of chemical mutagens to cause different types of mutations which includes missense alterations, truncation and mutations in splice junction sequences, high density of point mutations inducing series of alleles in target locus making it more suitable for targeting small genes or single protein domains that are encoded by large genes in contrast to insertional mutagenesis that mainly generates gene knockouts. The mutation induced by chemical mutagens is stable, which is not always the case for other reverse genetics approaches utilising RNAi silencing or transposon, e.g. Ac/Ds tagging. Furthermore, genetic transformation is pre-requisite for insertional mutagenesis and

RNAi technology through transposon tagging or T-DNA while no transformation is required for TILLING making it most acceptable non-GMO reverse genetics approach (taking into consideration the issues associated with genetic transformation) avoiding GMO procedures and controversies as well as for species that are recalcitrant to transformation. Moreover, TILLING is not technically demanding and can be performed at a relatively lower cost.

Variants of TILLING

Eco-TILLING

Not all species are amenable to chemical mutagenesis and hence, to extend the principal of TILLING to such species the concept of Eco-TILLING has been proposed (Comai et al. 2004). Eco-TILLING is similar to TILLING except that it is used to uncover natural genetic variation and discover putative gene function as opposed to use of induced mutations in TILLING. It can be used for rapid screening of many samples carrying the gene of interest for the identification of naturally occurring SNPs and or small INDELS. Additionally, Eco-TILLING can be used to determine heterozygosity levels within a gene fragment in highly heterozygous outcrossing species. Eco-TILLING, can also be a valuable tool for mining for SNPs in germplasm, assessing heterozygosity, uncovering variants for disease resistance, or ascertaining the function of a gene or regulatory element by detecting natural variants.

iTILLING

Recently, a new approach to TILLING has been developed for *Arabidopsis* that reduces costs and the time necessary to carry out mutation screening and is referred to as iTILLING (individualized TILLING; Bush and Krysan, 2010). As in TILLING, the process of iTILLING begins with the use of chemical mutagen EMS to induce mutations throughout the genome. The mutagen treated seeds are sown to raise M_1 population and the individual M_1 plants are then self-pollinated to yield M_2 seeds. At this step, unlike traditional TILLING, the M_2 seeds from the entire population are harvested in bulk and no cataloguing of M_2 individuals or DNA samples is required. Instead, M_2 plants are grown on 96-well plates and are screened for mutations. Further, only the individuals carrying a mutation of interest are sown to raise M_3 population. Although, iTILLING can reduce the investment and time required, it can only be used for a small number of genes as the screening population is short-lived and only plants with desirable mutations are allowed to grow till maturity and yield seeds for storage.

CONCLUSION

TILLING has been acclaimed as a highly effective reverse genetic tools for functional genomic studies in plants and animals and can be used in many model plant and animal systems regardless of their reproductive behaviour, genome size, or ploidy level unlike other reverse genetics approaches like RNAi, homologous recombination or insertional mutagenesis. However, mutation is the pre-requisite for application of TILLING and since not all species are amenable to be mutated, the method of Eco-TILLING has been

developed to uncover natural genetic variation, assess heterozygosity and mine for SNPs in germplasm.

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Rashtriya Gokul Mission: A holistic approach to conserving our indigenous bovine animals

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Abstract

India is having a vast reservoir of cattle genetic resources not only in terms of population but also in genetic diversity represented by 43 recognized indigenous cattle breeds and 16 buffalo breeds. Our country has some of the best indigenous breeds of cattle with traits for dairy, draught power and dual purposes. Indigenous cattle are suited to tropical climatic conditions, are able to resist the heat stress, need less water, can walk long distances, survive on local grasses and resist tropical diseases. They have the ability to survive and perform even under stressful conditions and low input regimes. However, genetic erosion of indigenous cattle breeds through uncontrolled cross-breeding and interbreeding is a problem of national concern and several local breeds are at risk of extinction. In this regard; recently, several measures have been initiated by Rashtriya Gokul Mission (2014) to increase the productivity of milch animals in their native tracts. Under this background, various breeding and reproductive technologies for selection and faster multiplication of genetically superior cattle have been adopted by few progressive Gaushalas to conserve our elite indigenous germplasm. Therefore, an integrated approach with due consideration to proper feeding, breeding, healthcare and improved management practices are recommended to address the future challenges and exploit the potential for sustainable conservation of our native bovine breeds.

Keywords: indigenous cattle, breeds, genetic, Rashtriya Gokul Mission

INTRODUCTION

Rashtriya Gokul Mission, a flagship programme of Government of India (GOI) under Ministry of Animal Husbandry, Dairying and Fisheries was initiated with an objective to develop and conserve the indigenous cattle breeds; thereby, improving their genetic makeup, enhancing the milk productivity and distribution of disease-free, high genetic merit bulls for natural service in a scientific manner. It is a focused project under National Programme for Bovine Breeding and Dairy Development.

Salient objectives of Rashtriya Gokul Mission (RGM):

- Development and conservation of indigenous breeds.
- To improve the genetic makeup and increase the stock of indigenous breeds through breed improvement programme.
- Enhancing milk production and productivity of the bovine population by increasing disease free high genetic merit female population and curb the spread of diseases.
- Upgrading non-descript cattle using elite indigenous breeds like Gir, Sahiwal, Rathi, Deoni, Tharparkar and Red Sindhi.
- Distribution of disease-free high genetic merit bulls for natural service.
- To bring all breedable females under organized breeding through AI or natural service using germplasm of high genetic merits.
- To arrange quality Artificial Insemination (AI) services at farmers' doorstep.
- To create an e-market portal (i.e. e-Pashuhaat) for bovine germplasm for connecting breeders and farmers.
- To increase trade of livestock and livestock products by meeting out sanitary and phytosanitary (SPS) protocols.
- To select breeding bulls of high genetic merit at a young age through the application of genomics.

Importance of Indigenous cattle breeds:

As per the Livestock Census (2012), India is having about 190 million cattle population, 79 per cent of which are indigenous and the rest 21 percent, constituted as crossbred. A decrease of about 4.10 per cent in the total cattle population of the country was registered as compared to the 18th Livestock Census. Also during this period, the indigenous cattle population decreased by about 8.94 per cent. The major factors for the decrease in indigenous cattle population are attributed to uneconomical returns due to low productivity and replacement of draft power in agriculture by mechanization. Further, due to several reasons including neglect of their genetic strengths (disease resistance, heat tolerance, work-capacity, ability to withstand natural calamities, tolerance to and conversion of low-quality forages, utilization of bio-mass, suitability and contributions to organic and natural farming, adjustment to local ecosystems) and their genetic dilution through uncontrolled crossbreeding and interbreeding. Indigenous cows being the backbone of rural life and economy in India play an important role in meeting the dietary needs of rural households. Our country has some of the best indigenous breeds of cattle with traits for dairy, draught power and dual purposes. Currently, the indigenous/non-descript cattle contribute about 21per cent of total milk production in the country. The milk of indigenous animals is high in fat and SNF content. Among indigenous breeds, cows producing good quality milk in lactation have been recorded under the Central Herd Registration Scheme for breed like Gir (3038-3263kg), Ongole (2000-2544kg) and Hariana (1671-4015 kg). Even among Malnad Gidda-dwarf cattle with a bodyweight of 80-120 kg, many cows give 3-4 kg of milk per day with regular calving under a low input production system. This indicates

that there exists a genetic potential for high milk production in indigenous breeds. Also, considering the looming climate changes, the adaptive characteristics of the local breeds would become more important in the future. Therefore, in this direction, the Govt. of India through Rashtriya Gokul Mission (2014) emphasized special attention to develop and conserve the indigenous bovine breeds. The mission envisages the establishment of integrated cattle development centre like "Gokul Grams" and "Gaushalas" to develop indigenous cattle breeds in their natural breeding tracts.

Strategies under RGM for the conservation of indigenous cattle breeds

1. Establishment of Gaushalas

"Gaushala" is derived from the Sanskrit word ("Gau" means cow and "Shala" means a shelter: Gau + Shala = shelter for cows), means the abode or sanctuary for cows, calves and oxen. Nowadays, many forefront Gaushalas are striving to maintain nucleus herd for *in-situ* conservation of indigenous purebred cows and produce quality males to enhance the productivity of indigenous breeds. Sadana (2009) in the study at NBAGR (National Bureau of Animal Genetics and Resources) reported that several Gaushalas (cow-herds) have been noted as potential centers for breed conservation and improvement. It has been recorded that purebred animals of several breeds (Sahiwal, Kankrej, Tharparkar and Hariana) are maintained in Gaushalas. Kumar (2009) observed that there was a substantial improvement in the growth, milk production and reproduction traits obtained from 1994 to 2008 due to better management and scientific breeding practices adopted in the Gaushalas in Hariana breeds. Kachhawaha *et al.* (2015) noted that in some parts of Rajasthan, Tharparkar bull was used for the Gaushala cows to improve the non-descriptive breed through grading up of area-specific indigenous breeds. Vij and Yadav (2010) emphasized that through proper planning and intervention, Gaushalas can become a potential centre for *in-situ* conservation of indigenous breeds and progeny testing of a large number of bulls.

2. Development of Gokul Grams

Gokul Grams are instituted as centres for the development of indigenous breeds and a dependable source for the supply of high genetic breeding stock to the farmers in the breeding tract. The Gokul Gram is self-sustaining and generates economic resources from the sale of A2 milk, organic manure, vermicomposting, urine distillates, and production of electricity from biogas for in house consumption and sale of animal products. The Gokul Gram will also function as state of the art, in situ training centre for farmers, breeders, veterinarians, etc.

3. National Kamadhenu Breeding Centre

Under RGM, two "National Kamdhenu Breeding Centres" (NKBC) i.e. in Itarsi, Hoshangabad (Madhya Pradesh) and Chintaladevi, Nellore (Andhra Pradesh) are being established as Centres of Excellence to develop and conserve indigenous breeds in a holistic and scientific manner. Its main objective is focused on conservation, promotion and development of 43 species of cattle germplasm.

4. *E-Pashu Haat*: An e-market portal connecting breeders and farmers, an authentic market, that facilitates buying and selling of quality- disease free bovine germplasm in

the form of i) semen; ii) embryos; iii) calves; iv) heifers and v) adult bovines with different agencies/stakeholders.

5. *Pashu Sanjivni*: An Animal Wellness Programme encompassing provision of Animal Health Cards ('*Nakul Swasthya Patra'*) along with UID identification and uploading data on National Data Base. This would simplify the process of monitoring and surveillance of large herd of cattle and keep their proper track record.

6. Advanced Reproductive Technology: This includes Assisted Reproductive Technique viz. In-Vitro Fertilization (IVF)/ Multiple Ovulation Embryo Transfer (MOET) and Sex Sorted Semen technique to improve the availability of disease-free female bovines.

***7. National Bovine Genomic Center for Indigenous Breeds (NBGC-IB*)** will be established for the selection of breeding bulls of high genetic merit at a young age using highly precise gene-based technology.

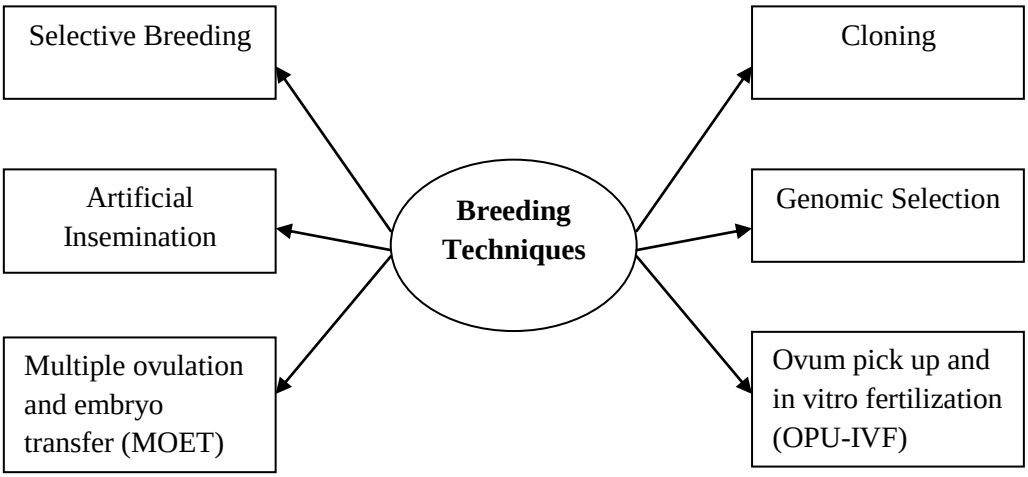

Fig.1 Improved breeding techniques for the conservation of bovine breeds

Suggestions for the effective functioning of RGM:

1. To upgrade the genetic merit of the non-descript and indigenous cattle through various breeding techniques in their natural breeding tracts as they represent the major share of the cattle population, thereby maintaining genetic biodiversity.
2. To develop fodder farms, feed preparation units and storage houses at state levels to meet the feed and fodder requirement of the cattle especially during the lean season.
3. To provide timely veterinary services at the farmers' doorstep and organizing vaccination and medical treatment through free veterinary health camps.
4. Giving technical know-how and capacity building in the form of training, workshops and field exposure to various stakeholders engaged in the conservation of local breeds.

5. Regular and timely allocation of budget for the development of Gaushalas and Gokul Grams.
6. Giving recognition in the form of awards/prizes (like Gopal Ratna award, Kamdhenu award) for encouraging farmers/breeder societies to rear indigenous breeds of bovines.
7. Seeking necessary technical guidance and support from institutes like National Dairy Research Institute, National Dairy Development Board, Indian Council of Agricultural Research and its Institutions, State Veterinary Universities and Colleges, etc.
8. Promote entrepreneurship through the sale of organic by-products from cattle like milk cow dung, urine, vermicompost, panchgavya, etc.

CONCLUSION

Rashtriya Gokul Mission plays a pivotal role in the sustainable conservation of our indigenous cattle wealth. It can act as a potential strategy for the in-situ conservation of the nucleus herd in their native tracts. Due to the decline in the population and productivity of indigenous breeds over the past few decades, it has posed a major challenge to our country. The need of the hour demands productivity enhancement in indigenous cattle, which could be achieved by the adoption of various modern technologies for selection and faster multiplication of genetically superior germplasm and adoption of improved animal management strategies. Therefore, the pre-requisite for the success of genetic improvement in Gaushalas are well-defined breeding goals, suitably designed breed improvement programmes, a user-friendly information system, active participation of all stakeholders including state govt. agencies and NGOs, efforts in developing common grazing lands and improving production environment and appropriate health care and management systems of the bovine livestock. Efforts must also be directed towards intensification and scientific intervention in terms of selection, breeding policy and managemental practices, etc. in Gaushalas or Gokul Grams for operative improvement and conservation of the indigenous germplasm.

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Passion Fruit (Granadilla)

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The passion fruit is a vigorous, climbing vine belongs to the family "Passifloraceae". It is originated from southern Brazil through Paraguay to northern Argentina. Brazil and Ecuador are the largest passion fruit producing country. In India, passion fruit is cultivated in around 9110 ha with 45820 tonnes production. In India, passion fruit is cultivated in North East states include Mizoram, Nagaland, Manipur and Sikkim and in South states including Karnataka (Kodagu region), Kerala (Munnar and Waynad regions) and Tamil Nadu (Nilgiri and Kodaikanal region). Passion fruit is known by different names such as Krishna Phal (Hindi), Krishna Kamalaa pandu (Telugu), Tatputpalam (Tamil), Utkatatene phala (Marathi), Doore hannu (Kannada) and Utkata phala (Gujarati). Fruit possess unique aroma and flavouring property, this fruit is used to produce a quality squash along with excellent nutritious juice. It is also used in preparation of ice creams, pies and cakes. Fruits are nearly round to oval shape and this tree vines are perennial, shallow rooted, woody and climbing by means of tendrils. Passion fruit has a lot of nutrients, essential for our health. It provides a wide variety of benefits from cancer to heart.

VARIETAL WEALTH

In Passiflora genus, there are around 500 species; among them *P. edulis* is most cultivated and known species. Within this species, there are two distinct forms, the standard purple (*P. edulis* Sims), and the yellow (P. *edulis* f. *flavicarpa* Deg.). There are many varieties of passion fruit available across the world. However, yellow passion fruit, purple passion fruit and 'Kaveri' Hybrid fruit (Purple x Yellow) are famous varieties of commercial cultivation in India. Yellow passion fruit is best for lower elevations and produce less yields at higher. Fruits are bigger in size (60-65 grams) than purple passion fruit. It is tolerant to diseases and pests. Purple Passion Fruit produce good yield at higher elevations. This variety fruits weight about 35 to 50 grams. Fruit turn to deep purple colour when ripe. Average juice content in purple passion fruit is between 30 to 35 %. The purple variety is best known for its flavour & nutrient content. A hybrid 'Kaveri' **(**90-110 grams each fruit) is the cross of purple and yellow passion fruit is high yielding compared to purple and yellow passion fruits. This hybrid has high degree of tolerance for common pests and diseases.

CULTIVATION PRACTICES

The passion fruit grows well in tropical to subtropical humid climatic. The ideal temperature required for best yield is from 20°C to 30°C. Passion fruit thrives best in well-drained sandy soils with pH range of 6.0 to 7.0. Passion fruit is propagated through seed, stem cutting as well as grafting. Seeds are generally sown during the month of March-April. Cutting (30-35 cm)is most popular method for propagation of passion fruit. Recently a serpentine-layering (February) technique has been standardized gives 90-95 percent success with 75 days of layering. Cutting or grafting originated vines starts fruiting much earlier (7-6 months) than those from seeds (10-12 months). Yellow passion fruit is used as rootstock to avoid damage due to wilt or root rot. Passion fruit vines are planted at a spacing of 3 meter x 3 meter and 2m X 3m in bower system and Kniffin system respectively during monsoon season. Frequent irrigation during dry period is advisable. For best yield of passion fruit, soil should be supplemented with optimum quantity of manures and fertilizers.

The flowers are borne singly in the axils of the leaves on current season's growth and systematic pruning of vine encourage new growth resulting in regular and higher yield of fruits. The lateral branches coming from leader branches are allowed to grow and fruit. Once the laterals have produced the fruits, they are cut back to four to six buds so as to induce regular bearing. Pruning is generally done twice in a year, first in March and April and another in October-November depending upon the harvest of the crop. There are two main periods of fruiting: the first harvest extends from August to December and the second one from March to May. The first fruits are obtained from the ninth month and full bearing is reached in 16-18 months. About 60-70 days are required from fruit set to the harvest of fruit. The fruit when ripe falls down from the vine. Harvesting is done when fruit turned slightly purple. Fruit should be harvested along with the stem. Purple passion fruit yielded around 10 tonnes /ha. In hybrid Kaveri variety, the yield would be high and about 18 to 20 tonnes/ha. Root rot, wilt or collar rot are the main diseases in passion fruit. The fruit fly and mites are the common pests. The effected branches or leaves should be pruned and destroyed. Yellow passion fruit is generally used as rootstock to control wilt and root rot.

Composition and Uses

As an edible fruit, it contains several components such as acids and sugars, nutrients, and nonnutritive phytochemicals that make passion fruit a tasteful and healthy addition to the diet. The yellow variety is used for juice processing, while the Purple variety is sold in fresh fruit markets. Passion fruit is a high acid food (pH~ 3.2) due to the predominance of two acids, citric (~93-96 % of total) and malic (3-6 % of total) acid. Fruit contain yellow pulpy juice possess unique aroma and flavour. Fruit is rich source of vitamin A and vitamin C and mineral content magnesium, sodium, chloride, sulphur *etc.* The yellow passion fruit has somewhat less vitamin C than the purple but is richer in total acid (mainly citric) and in carotene content. It is an excellent source of niacin and a good source of riboflavin. Fruit are processed into different forms. Fruit juice is major among different post harvest product of passion fruit. Fruit

juice is used in ice cream, syrup, tropical cocktails, and juice blends, and is rich in carotene, vitamin C and A, and potassium. Fruits are also processed into juice concentrate, syrup, butter, chocolates, purees, *etc*. Passion fruit juice can be boiled down to a syrup, which is used in making gelatin desserts, sauce, ice cream, candy, cake icing, sherbet or cold fruit soup. The seeded pulp is made into jelly or is combined with pineapple or tomato in making jam. Fruit rind can be chopped, dried, and combined with molasses as cattle or pig feed. Passion fruit seeds yield 23% oil, which is similar to soybean and sunflower oil possesses edible as well as industrial uses. Food value per 100 g of edible portion of fruit.

Energy	90 Calories
Moisture	75.1 g
Protein	2.2 g
Fat	0.7 g
Carbohydrates	21.2 g
Fiber	10 g
Calcium	13 mg
Phosphorus	64 mg
Iron'	1.6 mg
Sodium	28 mg
Potassium	348 mg
Vitamin A	700 I.U.
Riboflavin	0.13 mg
Niacin	1.5 mg
Ascorbic Acid	30 mg

The fruit has been used as a heart tonic and medicine, and fruit drink that is frequently used to treat asthma, whooping cough, bronchitis and other tough coughs in some areas. Also, the juice is used for urinary infection, mild diuretic, digestive stimulant and treatment of gastric cancer. The consumption of fruit promotes intestinal health and improves eye health and blood circulation. It improves the blood circulation and controls the blood pressure also reduce the risk of arthritis. Passion fruit is not only powerful source of antioxidant but along with its function as ant allergic and anti-inflammatory. Passion fruit tree leaves are used as a vegetable and tenders leaves are used for medicinal purpose.

Swaminathan Committee Report: An Overview

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National Commission on Farmers (NCF) was constituted on November 18, 2004 to address the nationwide calamity of farmer suicide and cause of farmer distress in India.The committee was mandated to give recommendations with following terms of suggestions

- A medium-term strategy for food and nutrition security
- Enhancing productivity, profitability, and sustainability
- Policy reforms to substantially increase flow of rural credit
- Special programmes for dry land, hilly area and coastal farmers
- Enhancing the quality and cost competitiveness of farm commodities
- Protecting farmers from imports when international prices fall
- Empowering local bodies to carry away measure for sustainable agriculture

The committee submitted five reports between the year 2004 and 2006. The reports contain suggestions to achieve the goal of "faster and more inclusive growth", which later became the theme for the 11th five year plan of India.

Major Observations of NRC:

Some of the major observations include

- Farmers' need for an assured access to and control over basic resources of farming such as land, water, fertilizers and pesticides, credit and crop insurance.
- Knowledge of farming technology and markets is also key.
- Agriculture and related issues must be implemented in the concurrent list, to make it a high priority for both state and central governments.

Recommendations of the National Commission on Farmers

The recommendation of Swaminathan committee can be studied under following heads such as asset reforms, reform in support services, farmers of the future, attracting youth, public policy and sustainable livelihood.

REFORMS OF AGRICULTURAL ASSETS

Land:

- Reforms in tenancy laws, land leasing, distribution of ceiling surplus land and wasteland, and consolidation of holdings.
- Prevent diversion of prime agricultural land and forest to the corporate sector for non-agricultural purposes.
- Wherever feasible, landless labour households should be provided with at least 1 acre per household, which will give them space for home gardens and animal rearing.
- Establish a National Land Use Advisory Service, which would have the capacity to link land use decisions with ecological meteorological and marketing factors on a location and season-specific basis.

Water:

Endeavour to evolve just and equitable mechanisms to give access to water and to include local people in the management of water resources. Following actions are needed to achieve this goal.

- Rainwater harvesting and aquifer recharge should be mandatory and farmers must be provided with financial assistance to make investment on such projects.
- Improved irrigation practices, including sprinkler and drip irrigation, should receive prior attention.
- Water literacy movement should be launch for the sustainable use of groundwater.
- Cultivation of high value but low water requiring crops like as pulses and oilseeds should be promoted in water scarce areas.
- Pani Panchayat in every village for equitable distribution of water.
- Water Users' Associations may be encouraged to gain expertise in maximizing the benefits of the available water.
- Drought Codes and Flood Codes may be introduced when situation is demanding to mitigate the extreme monsoon condition

Livestock:

The importance of livestock can be appreciated from the fact that it contributed 26% to agricultural GDP in 2004-05.So following steps should be taken high profitability from the sector.

- Establishment of Livestock Feed and Fodder Corporations at the State Level for easy access of quality feed and fodder
- National Livestock Development Council may be established to give integrated attention to all aspects such as breeding policy, feed and fodder, healthcare through Para-veterinary professionals, marketing, value addition, biomass utilization (skin, bones and blood) and efficient use of animal energy, for example, through improved bullock carts.
- Poultry rearing should be recognized as an agricultural activity and support should be provided to backyard poultry farmers to establish Small Holders' Poultry Estates.

Fisheries:

Fisheries provide livelihood to millions and income can be enhanced by Integrated Coastal Zone Management and scientific fish rearing, harvesting and processing. Potential from this sector is yet to be exploited and following action may yield fruitful result.

- Fish for All Training and Capacity Building Centres which will impart training to fisherman.
- Quality literacy to make Indian fish competitive in global market.
- Inland aquaculture, including the culture of ornamental fish and air-breathing fish for additional income.
- Artificial coral reefs to compensate for the loss of natural coral reefs to revive the fish catch which will also have a positive impact of ocean ecology.
- Establishment of bio-shields comprising mangroves, Casuarina, Salicornia, Atriplex and other halophytic plants, to safeguard the lives and livelihoods of coastal fishermen and farm families in the event of cyclonic storms and seawater inundation.

Bioresources:

Bioresources are the abundant wealth of flora and fauna including soil micro-flora and micro-fauna.

- Preserving traditional rights of access to non-timber forest products like medicinal plants, gums and resins, oil-yielding plants and beneficial micro-organisms. Conserving, enhancing and improving crops and farm animals as well as fish stocks through breeding.
- Prolific use of Genetic technology for the development of novel genetic combinations for important economic traits, such as resistance to biotic and abiotic stresses.
- Genome Clubs can be organized in rural schools and colleges for imparting an understanding of the importance of genetic resources conservation.
- A genetic and legal literacy movement must be launched in areas rich in agro-biodiversity regions.

Reforms in support services:

An effective as well as efficient support system such as science and technology, agro-climatic services along with credit and insurance etc act as a boon for agricultural development.

Science and technology:

- Every research must keep environment and small farmer in centre.
- Establishment of National Biotechnology Regulatory Authority to look in to safe and responsible use of recombinant DNA technology having adequate representative of farming community.

  Intellectual Property Rights (IPR) policies should make provision for compulsory licensing of rights in the cases of research products and processes of value to resource-poor farming families.

**Note: "Compulsory licensing is when a government allows someone else to produce a patented product or process without the consent of the patent owner or plans to use the patent-protected invention itself."

Agro- metrology:

- Formation of a National Land Use Advisory Service which was discussed earlier.
- An integrated internet-FM or HAM radio service to help fishermen fishing in the high seas.

Credit and Insurance:

- There is a need for both credit and insurance literacy in villages. Gyan Chaupals can help in this task
- Expand outreach of formal credit system; reduce crop loan interest rates to 4%
- Establish an Agriculture Risk Fund to provide relief to farmers in the aftermath of successive natural calamities
- Kisan Credit Cards should be issued to women
- Integrated credit-cum-crop-livestock human health insurance package
- Crop insurance across country for all crops with reduced premiums
- Drought-prone areas should have a 4-5 year repayment cycle for crop loans

Productivity Growth:

- Substantial increase in public investment in agriculture-related infrastructure particularly in irrigation, drainage, land development, water conservation, research development and road connectivity etc
- It also recommended a national network of advanced soil testing labs with an aim to test areas for apt micronutrient levels

Food Security

Mid-term appraisal of the 10th Plan revealed that India is lagging behind in achieving the Millennium Development Goals of halving hunger by 2015. Several studies have shown that the poverty is concentrated and food deprivation is acute in predominantly rural areas with limited resources such as rain-fed agricultural areas. To address this challenge NCF recommended following measures

- Implementation of a universal public distribution system to avoid exclusion error which will hardly incur 1% of GDP.
- Reorganise the delivery of nutrition support programmes on a life-cycle basis with the participation of Panchayats and local bodies.
- Eliminate micronutrient deficiency induced hidden hunger through an integrated food cum fortification approach.
- Establishment of Community Food and Water Banks operated by Women Self-help Groups (SHG), based on the principle 'Store Grain and Water everywhere'.
- Help small and marginal farmers to improve the productivity, quality and profitability of farm enterprises and organize a Rural Non-Farm Livelihood Initiative.

- Formulate a National Food Guarantee Act continuing the useful features of the Food for Work and Employment Guarantee programmes. By increasing demand for food grains as a result of increased consumption by the poor, the economic conditions essential for further agricultural progress can be created.

FARMERS OF THE FUTURE:

- **Cooperative Farming and Service Cooperatives**: It will benefit small and marginal farmers by providing centralized services like tractors, threshing and drying machines, to support small-scale decentralized production. This will bring down the cost of production and enhance the quality of products and thereby of income.
- **Group Farming:** promote the SHGs by encouraging groups to lease farmland.
- **Small Holders' Estates**: for crops like cotton, horticulture, medicinal plants, poultry and aquaculture will help promote group cooperation among farmers living in a village or watershed or the command area of an irrigation project.
- **Contract Farming**: Symbiotic contracts which confer benefits to both producers and purchasers will be ideal for ensuring assured and remunerative marketing opportunities. A Code of Conduct for Contract Farming will have to be developed.
- **Farmers' Companies**: Small farmers and SHGs should be associated with such companies as stakeholders and not just as shareholders.
- **Attracting Youth**: Youth will be involved in farming as a profession only if farming becomes economically rewarding and intellectually stimulating. Educated youth should be helped through a form of venture capital Fund, low-interest loans and allotment of wastelands for setting up agri-clinics and production-cum-processing centres to undertake outsourcing jobs both from within and outside the country.

Prevention of Farmers' Suicides:

In recent year farmers' suicide has emerged as a major crisis in rural India. The commission has suggested measures to tackle this challenge in following way

- Provide affordable health insurance and revitalize primary healthcare centres. The National Rural Health Mission should be extended to suicide hotspot locations on priority basis.
- Setting up Farmers' Commission in every state with representation of farmers for ensuring dynamic government response to farmers' problems.
- Provide for a Social Security net with provision for old age support and health insurance.
- Ensure availability of quality seed and other inputs at affordable costs and at the right time and place.
- Recommend low risk and low cost technologies which can help to provide maximum income to farmers because they cannot cope with the shock of crop failure, particularly those associated with high cost technologies like Bt cotton.

- Need for focused Market Intervention Schemes (MIS) in the case of life-saving crops such as cumin in arid areas. Have a Price Stabilisation Fund in place to protect the farmers from price fluctuations.
- Need swift action on import duties to protect farmers from international price.
- Public awareness campaigns to make people identify early signs of suicidal behaviour.

COMPETITIVENESS OF FARMERS:

- MSP should be at least 50% more than the weighted average cost of production.
- Availability of data about spot and future prices of commodities through the Multi Commodity Exchange (MCD) and the NCDEX and the APMC electronic networks covering 93 commodities through 6000 terminals and 430 towns and cities.
- State Agriculture Produce Marketing Committee Acts [APMC Acts] relating to marketing, storage and processing of agriculture produce need to shift to one that promotes grading, branding, packaging and development of domestic and international markets for local produce, and move towards a Single Indian Market.

Employment

In 1961, the percentage of the workforce in agriculture was 75.9%. While the number decreased to 59.9% in 1999-2000. But agriculture still provides the bulk of employment in the rural areas. The overall employment strategy must seek productive and qualitative employment. The measures to do so include:

- Accelerating the rate of growth of the economy;
- Emphasizing on relatively more labour intensive sectors and inducing a faster growth of these sectors
- Improving the functioning of the labour markets through such modification as may be necessary without eroding the core labour standards.

- Encourage non-farm employment opportunities by developing particular sectors and sub-sectors where demand for the product or services is growing namely: trade, restaurants and hotels, transport, construction, repairs and certain services.
- The "net take home income" of farmers should be comparable to those of civil servants.

Criticisms:

In one point the report complains lack of farm mechanisation in India and it is important for global competitiveness. But in another point it stress increase labour utilization to reduce unemployment. It is a major contradiction.

- Growing urbanisation and losses in agriculture make it lucrative for a farmer to sell his land for a non-agricultural purpose, bringing him windfall gains and thereby reducing the pressure on agriculture. NPF proposes to put restrictions on the use of agricultural land for non-agricultural purposes.

- It advocates to set up a corporation for livestock feed and fodder. But such corporations have been set up by the centre as well as several state governments for various purposes and none has done its job successfully and none has a clean record vis-à-vis corruption. Then why set up another corporation? Instead there is a need to make rearing of farm animals more remunerative by removing restrictions and allowing free trade.
- NPF talks about food security in this section but does not talk about leakages in the present public distribution system. Without plugging the holes in the present system, how can any security be provided to poor people**?**
- Swaminathan Committee's report fails to balance the price gap between the increase in the MSP and the cost of feeding the Indian population, which is highly middle- and lower class.

Bone of contention

Many of the recommendations were implemented with various schemes and laws by both central and state governments. However major disagreement lies in the recommendation on minimum supporting price (MSP).

- **NCF'S view**: The committee proposed MSP should be 1.5 times the farmers' input costs (or simply C_2+50%).While laying down the formula for calculating input costs to include the paid out cost (A_2), the imputed value of family labour (FL) added to the interest on the value of owned capital assets, rent paid for leased in land or rental value of owned land (C_2).
- **Government's View:** It says calculation of input costs will only include A2 and FL costs but not C_2 because the land rental costs are too diverse across the country.

CHALLENGES

There is a lack of political will on the part of the successive governments to address the issue of agricultural crisis. Instead of implementing a long term solution to the problems, temporary solutions such as loan waivers which have yielded rich political dividends. Loan waivers which were earlier viewed as extraordinary measures only to be adopted in cases of extreme emergency have now become a norm. While it provides only a temporary relief to the farmers, it has ensured political benefits to the ruling parties. Farm loan waivers are posing a bigger burden on the government exchequer compared to what higher pay for farm produce will incur. Thus, what is needed is a holistic policy framework based on the recommendations of the Swaminathan Committee, aimed at increasing the overall income and standard of living of the agricultural households especially when the government is targeting doubling farmers' income by 2022.

SUGGESTIONS

Swaminathan himself said "the government is willing to pay Seventh Pay Commission salaries to insulate government servants from inflation then why they cannot provide a

higher income for farmers to improve their lot." As per the latest projections, even by the year 2050, at least 800 million people will be living in rural India. Thus instead of shying away from agricultural reforms, the governments must address the challenges and implement strategies towards uplifting the standard of living of our farmers. We need to deal with various trades off between conflicting interests for overall wellbeing. For this purpose more options have to be explored with modern concepts to ensure security in agricultural markets and farmers' income.

Drip Irrigation:

An Innovative Approach for Agricultural Sustainability

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Abstract

The present and future challenges of Indian agricultural sector are growing due to population increase. The intensive cropping, cultivation of crops of high water requirement and declining ground water table might be major limitations to Indian agriculture. Water is a valuable and pre-requisite input for agriculture. Hence there is utmost need for efficient and judicious use of the available water. Micro irrigation such as drip irrigation is one of the innovative technologies which have potential to use every drop of water efficiently. Drip irrigation technology reduces conveyance losses, deep percolation losses, runoff, seepage and evaporation losses significantly and as a result ensures water use efficiency as much as up to 90%. Promotion and adoption of such water efficient technologies are required for better utilization of available water resources for increasing the production potential of arid and semi-arid regions of country.

INTRODUCTION

The growing world population and continually increasing need of water is likely to cause water scarcity in the coming years. The irrigated area consists of about 36 per cent of the net sown area. At present, the agricultural sector accounts for about 83 per cent of all water uses. Hence, there is an urgent need of judicious and efficient use of the irrigation water for sustainable agriculture and micro-irrigation is one such innovative technology. Drip irrigation and sprinkler irrigation are the commonly used micro-irrigation methods. The traditional methods of irrigation such as surface flooding causes water losses due to mainly water conveyance and application leading to reduced irrigation efficiency(<30 %) as compared to the micro irrigation methods. These losses could be reduced by adopting drip and sprinkler irrigation methods.The drip irrigation is the most efficient method among all the irrigation methods which offers higher water and fertilizer use efficiency and can be practised for large variety of crops, especially vegetables, orchard crops, flowers and plantation crops. In drip irrigation method, water and nutrients are applied directly to the root zone of plants through an

arrangement of pipes, valves and emitters. The drip irrigation has potential to reduce the losses of water through evaporation and percolation.

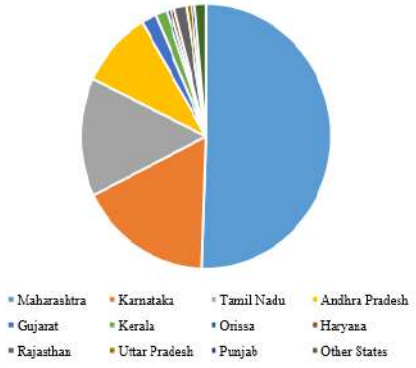
Drip irrigation: An Innovative Technology

Water scarcity in several parts of the country has created awareness about micro-irrigation systems and their implementation results in significant social and economic benefits to the farming community of the country. The use of micro-irrigation method benefits in terms of water saving increased crop yields, reduction in the use of chemical fertilizers. The actual water saving could be achieved by improving the water productivity for agriculture through efficient irrigation at farm level and the saved water can be used for the irrigation of additional acreage or for environmental and social needs.

Current Status of Micro-Irrigation in India

According to the study of IAI and FICCI, the average penetration level of micro-irrigation in the country is 5.5 % which is much less than the other countries. In India only few States have the penetration level greater than the national average and these States are Haryana (16.3%), Sikkim (10.8%), Andhra Pradesh (10.4%), Rajasthan (9.3%), Karnataka (8.5%), Gujarat (8.1%), Maharashtra (7.3%) and Tamil Nadu (6.4%). In the recent years (2012-15) there was a strong demand for drip irrigation and its growth rate (CAGR 9.85%) during this period outweigh the growth rate of sprinkler irrigation (CAGR6.6%). Presently, the area under micro-irrigation is only 7.97 Mha which is dismal compared to large rain fed area in India. The area in top five States in India under micro-irrigation are Rajasthan (16.85 Mha), Maharashtra (12.71 Mha), Andhra Pradesh (11.63 Mha), Karnataka (8.47 Mha) and Gujarat (8.29 Mha).

Figs. 1 and 2 show the status of area under drip irrigation in the year 2000-01 and 2015-2016 in India (Horticultural Statistics at a Glance 2015).



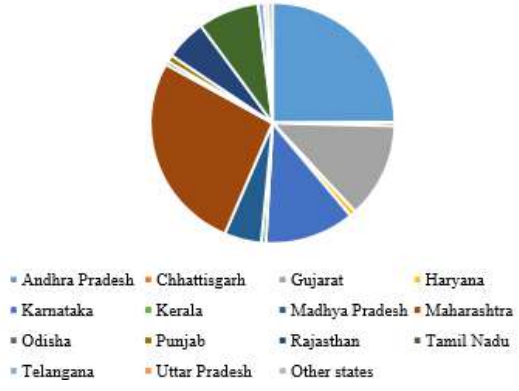


Fig.1 State wise % share during 2000-01 Fig. 2. State wise % share during 2015-16

(Area Covered under Drip Irrigation in India)

Source: Based on data of Horticultural Statistics at a Glance 2015

Tremendous increase has recorded in the area under drip irrigation of Maharashtra, Karnataka and Tamil Nadu where area has increased about fivefold on account of the states like Gujarat, Andhra Pradesh, Rajasthan and Madhya Pradesh.

Advantages of Drip Irrigation

- Drip or trickle irrigation requires less than half of the water needed for sprinkler irrigation.
- Reduced energy costs for pumping by lower operating pressures**.**
- Higher water-use efficiency can be achieved because plants are supplied with more precise amounts of water.
- Less incidences of disease infestation because plant foliage remains dry.
- Lowers the labor and operating costs.
- Water supplies are made directly to the plant root zone resulting in better weed control and significant water savings.
- Field operations can be done during irrigation because the areas between rows remain dry.
- Fertilizers can be applied efficiently through the drip system.
- Irrigation can be done under a wide range of field conditions.
- Soil erosion and nutrient leaching can be reducedas compared to sprinkler irrigation.
- Judicious use of water increases the farmers' income.

Constraints and Limitations of Drip Irrigation

- Higher initial investment costs per acre than those of other irrigation options.
- Management requirements are higher and delaying critical operation decisions may cause irreversible crop damage.
- Rodent and insect damage to drip lines are potential sources of leaks.
- Water filtration is necessary to prevent clogging of the small emitter holes.
- Drip irrigation is more suitable for widely spaced crops though this technology has been applied to more than 80 crops.
- Inadequate follow up services by the drip agencies.

Challenges for Adopting Drip Irrigation

- Lack of reliable guidelines
- Unavailability of subsidy funds for installation of drip systems
- Inadequate focus on dissemination of innovative technology nationwide
- Inefficiency in implementation due to the lack of implementation strategies
- Lack of awareness among the farmers regarding its use and advantages
- Non availability of soluble fertilizers

CONCLUSION

The drip irrigation method for applying water has potential to increase crop yield, water use efficiency, fertilizer use efficiency, reduce water losses and energy consumption and minimal weed problems especially in cash and widely spaced crops. However, it is necessary to impart training to the farmers about proper use and maintenance of drip systems for getting the maximum benefit and efficient use of drip irrigation for crop production.

ABBREVIATIONS

IAI: Irrigation Association of India FICCI: Federation of Indian Chambers of Commerce &Industry CAGR: Compound Annual Growth Rate

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Backyard Japanese Quail Farming:

A new venture for rural farmers

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The Japanese quail (*Coturnix coturnis japonica*), in Hindi called 'Bater' is raised for egg and meat production. It is one of the best source of non-vegetarian diet and a good converter of agri-byproducts or cereals to animal protein. The quality of 'Bater' meat is very high due to low calorific values, nutrient contents is more, very tender, juicy and delicious meat. The dry matter content in quail meat is high. To boost up the family income particularly for poor farmers who do not have any other source for high investment for diversified farming can easily opt for low cost quail farming. Initial investment is very less in comparison to other livestock farming and suitable for landless and marginal farmers. It is ideal for backyard farming also. Quail is a small bird and weigh about 200 to 250 gm at mature age. Generally males are lighter than female. Identification of male and female can be done at 3 to weeks of age. Males are cinnamon colour at upper portion of breast and lower portion is having light brown in shade. Female colour varies from brown with black markings in throat, face and upper portion of breast but, tan colour in lower portion. In male there is hypertrophied gland in cloeca. The newly hatched chicks are brown in colour with yellow stripes. At the age of 6 weeks female start laying and at 50 days age starts full production. On an average a quail lays 280 eggs/ year. The egg weight is 10 to 12 gm and colour of egg shall is white to brown with dark coloured mottling and often covered with a light blue chalky material. Generally quail lay eggs at evening hours between 3 to 6 pm and in some cases at night. Throughout the year quail lay eggs. The egg of quail is handled very carefully because of very thin egg shell. Eggs are collected 2 to 3 times a day to avoid egg loss. The weight of hatched chick is 0.8 gm and unsuitable for transportation. Hence, they are reared at production site up to 2 weeks and thereafter shifted to farmers' door. At the age of 5 weeks they weigh about 180 to 200 gm.

Why to start Japanese quail farming?

1. Japanese quail is very prolific and have short generation interval.
2. Have twin capacity for egg and meat production.
3. Japanese quail meat with low calorific value and high protein content it is recommended for children, old family member and pregnant women.

Fig.1 Backyard Japanese quail farming (Source: *www.backyardquail.com*)

4. It is one of the cheapest sources of animal protein and can be adopted as backyard farming for egg and meat production.
5. Due to hardiness and adoptable capacity the quail can thrive in adverse conditions also when other livestock easily collapse.
6. For rural poultry and backyard farming quail farming can be started with minimum investment.
7. Space requirement and demand for feed supply is very less in comparison to other livestock like poultry.
8. Laying capacity is more and meat quality is better.
9. Resistant to most of the poultry diseases and require no vaccination.
10. High economic return and can be utilized for egg and meat purposes as and when required.

HOUSING OF JAPANESE QUAIL

The optimum room temperature and relative humidity at quail house is 15 to 20^0 C and 40 to 70 %, respectively. The birds can be reared in litter system or in cage. If litter system is practiced, locally available bedding material can be used. The room should be well ventilated, insulated and free from dust. Dry litter approximately 10 cm thick may be provided in deep litter system. The bird should also be protected from predators like dog, cat, rodents, hunting birds etc.

For a quail up to 4 weeks of age 145 to 150 sq cm is sufficient, but up to 5 weeks and above 250 sq cm is required. In general in deep litter system 70 birds can be housed in one sq mt area and in cage system 80 birds per sq mt area. Sometimes the quail hide their eggs inside the litter. Hence, the cage housing is preferred in quail farming to reduce the egg loss. The size of the cage may be 13 x 20 cm for two birds. To get the optimum production hygiene and sanitation is must for quail farming. The quails are

territorial in nature and they defend their home from other new entrants. If two groups of birds are introduced in same cage or in room, may be placed both of them in new cage to avoid infighting.

Japanese quail can be raised in multitier system. The length of the tier is 120 cm, height 25 cm and width 60 cm. Twenty to 40 birds can be housed in one tier. The space requirement for feed and water is 2.0 cm and 1.0 cm up to 3 weeks of age and 3.0 cm and 1.5 cm, respectively up to 3 to 6 weeks and above. To avoid feed loss the feed trough should be filled up to three forth and there should be provision for clean drinking water throughout the day. Quail house should have facility for 14 to 18 light hours for optimum feed intake and egg production. In winter months or in rainy days extra light may be provided in the quail house. If quails are raised commercially for meat purposes 24 hours light may be provided for early growth and higher market value.

Fig.2 Housing for Japanese quail farming (Source: *www.backyardquail.com*)

BREEDING OF JAPANESE QUAIL

The ideal age of breeder is 10 to 30 weeks. During 2 to 8 months of age group fertility remains maximum in Japanese quails and after that gradually declines. The male female ratio should be 1:3. Before incubation eggs may be stored at 13^0C with 70 to 75% humidity after fumigation. Eggs may be stored up to 7 days. Beyond 7 days hatchability will be reduced. Eggs are stored in a plastic bag to reduce dehydration.

SELECTION OF HATCHING EGGS

Clean, defect less and sound eggs may be selected for incubation. A medium size egg selected for hatching should have 10 to 11 gm weight. The eggs are disinfected before incubation by fumigation with formaldehyde gas for 15 to 20 minutes which contains

Potassium permanganate and 40% formalin. After fumigation eggs are arranged in setting tray by keeping broad end up for incubation.

Incubation of eggs

Eggs are incubated for 17 to 18 days. Up to 14 days from day one the temperature of incubator should be 37.5 ± 0.3^0C with 60% humidity. After 14^{th} day till 17^{th} day relative humidity should be maintained up to 70% in hatcher. During incubation period eggs are turned uniformly 8 times/day or every 2 to 4 hours to prevent sticking of embryos to egg shell. On 17^{th} or 18^{th} day chicks hatch out from egg.

Care for newborn chicks

Care for chicks in 1^{st} week is very important because the chicks are very delicate and weigh only 7 to 8 gm. Chick mortality may occur if proper care and management is not provided to newborn chick. There should be provision for 24hrs light in brooder house. If there is light failure chick may huddle together and collapse. Sometimes chicks drown in waterer. To avoid chick drowning pebbles may be given inside the waterer and also corrugated paper may be spread over the litter or wire mesh to avoid sprawling of legs during 1^{st} week after hatching. It is advisable to put about 150 or less chicks in a single brooder for prevention of stampeding.

Different types of brooder can be used for quail brooding, namely floor brooding, battery brooding, gas brooding etc. Heater or electric bulb may be used for provision of heat generation in brooder house. Battery brooding is advantageous than floor brooding. The brooder house temperature should be initially 37^0C and gradually temperature may be decline at the rate of 3^0C for every 4 days. Generally brooding is done for 3 weeks but provision for extra light may be continued for 5 weeks for early maturity and growth.

FEEDING MANAGEMENT OF JAPANESE QUAIL

Feed alone consider 70% feed cost of quail farming. Hence, the feeding should be balanced, economical and with preferably with locally available material may be used for feed formulation. In backyard quail farming agri-byproducts and household leftover food grains may be utilized for maximum profit. In backyard farming it is always advisable with minimum input maximum gain. However, for commercial or medium to large scale quail farming balanced ration with 2700 to 2800 ME Kcal/kg of feed, 22 to 27% protein and adequate calcium (3%) particularly during laying period and phosphorus (0.8%) along with vitamins and minerals may be provided in quail ration. During early stage i.e. in starter and grower period the demand for essential amino acid and protein is more and for optimum growth molasses at the rate of 6 to 8% may also be provide at least for 3 to 4 days. An ideal quail ration may be prepared with following ingredients.

Table1. Recommended rations (per quintal of feed) for Japanese quail

Ingredients	Starter ration	Grower ration	Layer ration
Rice polish	14	9	10
Maize	43	35	40
Groundnut cake	16	30	25
Sunflower Cake	14	12	10
Fish meal	10	12	10
Bone Meal	1.4	0.7	0.2
Lime Stone	1.0	0.5	0.5
Salt	0.3	0.5	0.5
Vitamins and Minerals	0.3	0.3	0.3

According to age group feed consumption varies. During 1st week it is 5 gm, 2nd week 10 gm, 3rd week 15 gm, 4th week 19 gm, 5th week 22 gm and 6th week and above 25 gm. An adult quail daily consume 20 to 25 gm feed.

Health care management for Japanese quail

Unlike other poultry species no special care or attention is required for Japanese quail except environmental stress. During first two weeks the chicks remain very fragile and environmental changes particularly in summer and winter months required special care like protection from summer or winter stress, hot or cold wind, heat stroke etc.

Quail are resistant to some of the poultry diseases like Ranikhet disease, Fowl pox etc. Quail do not require vaccination, deworming however, regular cleaning and hygiene is must in quail farm. To prevent cannibalism debeaking is recommended in commercial quail farming. Debeaking can be done with simple nail cutter. But, over cutting of beak may lead to lower fertility in quail due to mating problem in males.

Source: Handbook on Animal Husbandry, ICAR and Text books on poultry production

Health Management and Maintenance of Brood Fishes

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Fish health management is a very well recognized term in aquaculture, which is used to describe different managemental practices for the purposes of prevention of fish diseases. Fishes especially brood fishes are very much vulnerable to different transboundary diseases. So, utmost care is needed to prevent the spreading of different diseases at this stage. Care of brood fish to maintain them in a healthy condition is called brood fish health management. The main objective of the broodstock health management is to make brooders available in proper condition during the breeding season. In order to fulfill this objective, brood fish should be taken care in well managed and maintained ponds, so that their proper sexual developments can occur.

THE SIGNIFICANCE OF BROOD FISH DISEASES IN AQUACULTURE

The diseases of brood fish are nothing but a simple association and interaction between pathogen and a host fish. Brood fish disease is an important cause of losses to fishermen and aquaculturists. Diseases of brood fish also act as a carrier of diseases for fish species of future generations. Disease outbreak among brood fishes causes substantial and considerable problems especially when fishes are in crowded condition and stressed under culture conditions. So, stress is the most important factor which can create a synergistic effect on the outbreak of diseases. So, managemental practices should be directed to limit these stress conditions. These are likely to be most effective in the prevention of disease outbreaks.

TYPES OF FISH DISEASES

There are two broad categories of diseases that can encounter fish. These are infectious and non-infectious diseases.

A. Infectious diseases: They are broadly divided as parasitic, bacterial, viral and fungal diseases. They are caused by mainly pathogenic organisms which are present in the environment. They are very much contagious in nature.

- **Parasitic diseases:** These diseases of fish frequently caused by protozoa, which are very small microscopic organisms. Most important symptoms of parasitic diseases are an infestation of gill and skin of fish, irritation, weight loss and death.
- **Bacterial diseases:** Bacteria mostly cause internal infections of fish. Treatment of bacterial diseases should be done with medicated feeds. Symptoms of bacterial diseases are hemorrhagic spots, body wall ulcers and ulcers around eyes and mouth, enlarged abdomen and protruding eyes. Columnaris is an example of an external bacterial infection resulting from rough handling.
- **Viral diseases:** Difficult to diagnose and have no specific medications.
- **Fungal diseases:** Fungal spores are very common in the aquatic environment but do not cause diseases in healthy fishes. Formalin or potassium permanganate provides the most effective treatment against fungal infections.

B. Non-infectious diseases: Non-infectious diseases can be broadly categorized as environmental, nutritional or genetic.

- **Environmental diseases:** They are most important in commercial aquaculture. These diseases include low dissolved oxygen, high ammonia, high nitrite or presence of natural or man-made toxins. Proper water quality management can be the only weapon through which we can prevent environmental diseases.
- **Nutritional diseases:** Very difficult to diagnose. Affected fish become anemic and may die.
- **Genetic abnormalities:** This includes lack of tail or presence of an extra tail. Most important measure, through which genetic abnormalities can be avoided, is to minimize the chances of inbreeding by bringing unrelated fish for use as broodstock.

STEPS OF BROOD FISH HEALTH MANAGEMENT

Selection of pond for brood fish

- ✓ Size: 0.5-1.0 ha.
- ✓ Depth: 1.5-2.0 m
- ✓ Shape: Rectangular.
- ✓ Slope: Uniform.
- ✓ The pond should be with proper drainage system with inlet and outlet facilities.
- ✓ In order to provide the riverine condition, adequate flashing system should be present in the brood fish pond.
- ✓ The pond should be well protected from flood and drought.
- ✓ The pond should be situated in such location so that it can get sufficient wind.
- ✓ The pond should be exposed to bright light for 6-8 hrs/day for 2-3 month.
- ✓ Temp should be between 27-32°C.

Selection of brood fishes

Breeders should be of-

- ✓ Healthy
- ✓ Disease-free
- ✓ Age group should be in between 2-4 years.
- ✓ Weight range should be in between 1-5 kg.

Sources of brood fish

- ✓ Sources should be different river systems, in order to avoid inbreeding.
- ✓ The selective breeding process can be used for the selection of the brood fishes.
- ✓ In order to avoid inbreeding depressions, fresh fish germplasm is introduced from natural sources with timed periodicities.

Stocking of brood fish

- ✓ Stocking rate: 1000-3000 kg/ha.
- ✓ Stocking ratio: 4:3:3
- ✓ In the Indian tropical environment, the species ratio should be quite proportionate, so that different niches of water bodies become fully exploited.

Fertilization of pond

- ✓ Firstly, the initial manuring of brood fish pond should be done three weeks prior to stocking. It is to be done with cattle dung @ 20,000 kg/ha or with compost manure which is prepared from land/aquatic weeds and farm animal droppings.
- ✓ Compost manure is prepared by mixing land /aquatic weeds and farm animal droppings at the ratio of 1:1 with 5% quick lime @ 10,000kg/ha.
- ✓ Quick lime treatment @ 200 kg/ha should be given in the pond before 7 days of the stocking of the pond.
- ✓ Apart from these, monthly treatment with raw cow dung @ 2000kg/ha also can be provided.

Other managemental strategies

Regular netting should be done

- ✓ To increase the dissolved oxygen level of the pond.
- ✓ To make the fishes remain always active in the pond.
- ✓ To remove harmful gases from the bottom of the pond.

Supplementary feeding

- ✓ Supplementary feeding in the pond should be continued until water blooms appeared.
- ✓ Supplementary feeding should be done with well-balanced food at a fixed schedule.
- ✓ Further feeding should be resumed when a bloom will be disappeared.

Feed composition

- ✓ Semi-composite mixture: 50%.Made from half-cooked rice and pulses at the ration of 1:1.
- ✓ Oil cakes: 20%.
- ✓ Cattle dung: 20%.
- ✓ Fish meal/silkworm pupae
- ✓ Cooked slaughterhouse refuses: 10%

Manners of the feeding

- ✓ Feeding should be done on sunny days and stopped on cloudy days.
- ✓ Sometimes, vegetative matters like Hydrilla, Valisnaria, Najas, Utricularia are used as supplementary feeds to get better growth of brood fish.
- ✓ Grass carps are always given vegetative matter and silver carps are given thick planktons like Spirulina, Oscillatoria and Chlorella.
- ✓ Feeding rate should be decreased with advancement of maturity of gonads.
- ✓ Before one week of breeding, feeding should be stopped.

Inducement

- ✓ To increase Gonado-somatic development of brood fishes, 30 IU/kg HCG powder, diluted with 10 mg/ml distilled water is given to catla and grass carp spawners at 5 mg/kg at a gap of one month during last week of December, January and February.
- ✓ Rohu and Mrigal are treated with 2 doses of HCG at 4 mg/kg body weight in the last week of December and 1st week of February.
- ✓ Silver carps do not require any inducement dose.

Some important steps

- ✓ If surfacing of the fish is seen, due to DO depletion, then immediately application of manure and supplementary feeding should be stopped.
- ✓ Freshwater should be added.
- ✓ Pond water should be agitated.
- ✓ Small banana plants pieces to be scattered in the pond.
- ✓ Repeated netting should be done.
- ✓ 30-40 kg/ha common salt to be applied.

CONCLUSION

Successful fish health management greatly depends upon the prevention of diseases than treatment as we know that prevention is always better than cure. Good water quality management can be one of the best weapons through which we can prevent diseases successfully. Nutrition and sanitation are the other two factors which can have a synergistic effect upon disease prevention of fish, especially of brood fishes.

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Role of Traditional knowledge for water harvesting in India

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We are living in the era of rapid globalization and industrialization where each and every country is trying to become more and more advanced in terms of innovation, research and technology. But in this race, we have forgotten our nature which is playing an important role in our development. We can get clear cut idea from one of the Mahatma Gandhi's quote according to which there is enough on Earth for everybody's need, but not enough for everybody's greed. Present situation is showing that we are becoming more and more greedy and destroying our natural resources at a very fast rate without taking care of their regeneration and availability for future generation. Water is one among those precious natural resources which is being used in large amount in agriculture, industries, and homes and in short in all our day to day activities.

Due to increase in population, it has become very difficult to provide safe water to everyone and also due to our negligence; we are overexploiting our water resources without taking care of their recharge. India is highest user of groundwater in world (we use 25% of all groundwater extracted globally). Approximately 4 crore irrigation wells are present in our country and millions of farmers are dependent on them for irrigating their fields. Share of groundwater in agriculture was 35% at the time of independence but green revolution resulted in highest extraction during 1960s and 1970s and today it has reached to 70%.

Inspite of all this, our forefathers were very concerned about the conservation and efficient utilization of natural resources. Area wise they were having their unique way of using resources and also conserving them for future generation. Different practices are being adopted from a very long time in different parts and 'Zabo' system in Nagaland is one such example of traditional knowledge having scientific basis.

Village Kikruma in Phek district of Nagaland is occupied by people of Chakhesang tribe, who are following this 'Zabo' system. At an elevation of 1270m, at 25°36' N latitude and 94°10'E longitude. People have developed this system to meet their requirements of water for irrigation and drinking and thus are growing plenty of food and conserving the environment. As shifting cultivation is one of the way of farming in N-E part of India where people use to cut forests and then crops are grown there for 2-3 years and then location is abandoned and new land is choosen for cultivation in the same way. This has

resulted in deforestation and problem of soil erosion but this Zabo system helped in checking the deforestation, controlling soil erosion and increased the availability of water. Village Kikruma is situated in the rain shadow and is situated on a ridge between two streams viz. Seidzu and Khuza, on the southern and northern sides. Streams are present in downside and people were not able to take water from them to the top of hill, so this resulted in evolving a system of rain water harvesting on the hill tops for fulfilling domestic needs and also for irrigation. Both soil and water management is the main component of this system.

About The System:

In local language, the word 'Zabo' means impounding of water. At the top of hill, it has forest land. Further down the hill slope, water harvesting ponds (ponds for retention of silt and for water storage) are present which are followed by livestock enclosures and in last at the foot of hill, terraced rice fields are present. Individual farmer follow this system and sometimes 10-15 farmers join together.

Components:

1. **Forest land**
2. **Water harvesting unit**
3. **Cattle house/enclosure**
4. **Agricultural land**

1. **Forest Land**

Top of hill act as a catchment area for rainwater and is fully covered by natural vegetation. Although this area is extremely steep but due to covering of permanent vegetation there is no soil erosion and no cutting of trees is done in this region.

2. **Water harvesting unit**

By digging out earthen embankments, water harvesting ponds are made just below the catchment area. Depending on the size of catchment area, tanks with depth of 1.5-2.5 m are made with capacity varying from 300-600 m^3. Two small ponds are created as silt retention tanks followed by a big tank. As silt retention tanks store soil, humus and organic matter along with water, so these tanks are desilted annually and material is put in the fields to increase the fertility of soil. To avoid seepage losses from main tanks, inner surfaces of tank is plastered by mud mixed with chopped paddy straw. Animals are let loose in the tank to make the bottom surface of tank hard, before water is stored.

3. **Cattle house/enclosures**

These are generally made by using local wood and bamboo available there and group of farmers stock cattle on a rotation basis and about 30-50 animals are kept for a period of 10-15 days. Common animals are Buffaloes, Cows and Pigs. When crop require irrigation, then water from main tank is allowed to pass through these enclosures which help in movement of dung and urine from enclosures to the field which help in increasing the fertility of soil.

CONCLUSION:

This system is an excellent example of judicious use of water by using locally available resources. As there is no cutting of forests, so help in controlling the soil erosion and conserving the environment. No system can work in isolation and here Forest, Water, Soil, Animal, Crop and finally human, all are integrated to make the system productive, profitable, ecologically sound and sustainable.

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Managemental Strategies for Increasing Nitrogen Use Efficiency

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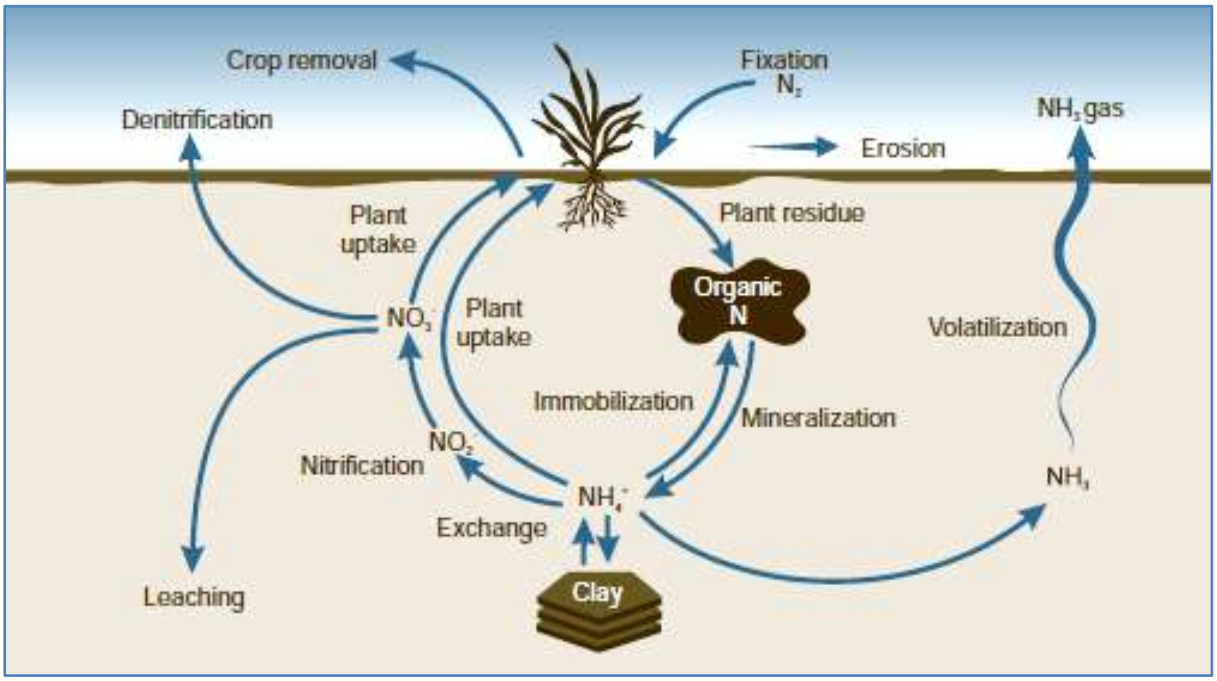
Nitrogen (N) is the most important primary nutrient element for plant growth. It acts as the key constituent of amino acids, proteins, plant growth hormones like auxins, cytokinins and many other alkaloids. An adequate amount of N is required to carry out photosynthesis in the plant as it is a part of the chlorophyll molecule. More than 90% of N in soils is found in organic forms like amino acids, nucleic acids, amines, glycerol phosphate, vitamins and more complex organic molecules. A huge amount of N_2 gas is present in the atmosphere which gets converted to ammonia (NH_4^+) and nitrate (NO_3^-) for plant uptake. Indian soil is deficient in N which is a limiting factor for plant growth and yield. In India, most commonly used N fertilizers are urea, calcium ammonium nitrate (CAN), ammonium sulfate that contains a significant amount of N and is effective only when properly applied.

THE NITROGEN CYCLE

The N cycle begins with the simplest stable dinitrogen (N_2) form which undergoes different processes like mineralization, immobilization, fixation, nitrification, denitrification, leaching, volatilization through the different process by microbial activity. Nitrogen in the soil solution is predominately present as NO_3-N which is barely adsorbed to the soil and therefore more affected by leaching, as well as NH_4-N which, however, is largely bound to soil particles. Nitrogen enters the soil from the atmosphere through dry and wet N deposition, organic and synthetic fertilizers and biological N fixation. Organic N pool enhanced by decomposition of crop residues. Nitrification is the process of conversion of the NH_4-N into NO_3-N by the microbes *Nitrosomonas* and *Nitrobacter*. Losses of N from soil occurs through leaching with percolating water, NH_4^+ volatilization to atmosphere and denitrification of various gases (NO, N_2O, N_2) under different environmental conditions. Sometimes, a large proportion of total N locked up in clay complex and gets fixed reducing the availability of N for plant uptake. The

quantity and forms of N are dynamic in nature due to physical, chemical and biological processes. The challenge of improving N is to achieve maximizing N availability to the crops when they need it and reducing the loss of N to the environment. This can be achieved by understanding the N cycle and managing inputs.



The Nitrogen cycle

NITROGEN USE EFFICIENCY (NUE)

Nitrogen use efficiency is the ratio of grain yield per unit of available N in the soil, including the present residual soil N and fertilizer N.

NUE = (N exported from field into crops) / (N applied)

However, not all available plant N comes from N fertilizer. It is a function of soil structure, climatic conditions, interactions between soil and bacterial processes and the nature of organic and inorganic N sources, which is not included in the formula above. Apparent recovery efficiency (REN) defined as the percentage increase in N uptake by the plant in aboveground biomass per kg N applied and reflects the NUE.

$$REN = (NU_N - NU_C)^x 100/F_N$$

where,

NU_N= Total plant N uptake in aboveground biomass at maturity in a plot that received fertilizer N (kg ha^{-1})

NU_C= Total plant N uptake in aboveground biomass at maturity in a plot that received no N (kg ha^{-1})

F_N= Amount of fertilizer N applied (kg ha^{-1})

It is necessary to reduce N fertilizer application in the agricultural system by increasing NUE as it is very low in crops (40-60%) especially rice (30-40%). High NUE can be achieved through balanced fertilization combined with other agricultural practices like improved varieties, water management that maximize nutrient uptake by plants. Improved synchrony can be done by more accurate N prescriptions based on the

projected crop N demand and levels of N in soil by using decision aids to diagnose N status in plant and soil during the growing season. The optimal fertilizer N rate varies from field-to-field due to variation in both crop N demand and soil N supply.

EFFICIENT NITROGEN MANAGEMENT PRACTICES

1. Nitrogen application rates: Soil testing and plant analysis are important tools to consider the N supplying power of the soil in relation to crop requirement. The rate should be adjusted in such a way so that N supply should balance with crop removal to avoid loss the N and its deficiency. Excessive N supply may lead to toxicity symptoms as well as subject to environmental problems. Symptoms of excess are reduced yields because the crop is more susceptible to pests and diseases and also to lodging.

2. Timing of nitrogen applications: Nitrogen should be applied at that stage of the crop when they need the most. Split application of N at various times is important to avoid leaching, denitrification loss which is helpful for improving NUE. Nitrogenous fertilizers are applied to the soil closer to the crop for plant uptake to maximize efficiency.

3. Nitrogen application methods: Placing manure or fertilizer directly into the soil is most efficient, but other than that banding, foliar application, conservation tillage can also help to increase the efficiency of nitrogenous fertilizers. The right place of fertilizer also depends upon the nature of fertilizers being applied. Nitrogenous fertilizers like urea and anhydrous ammonia are susceptible to various losses when they are applied at the surface.

4. Real-time site-specific N management: Site-specific N management involves the use of diagnostic tools and models to assess real-time N demand of the crop with respect to its supply. These include chlorophyll meters, leaf colour charts (LCC), an optical sensor like green seeker etc.

4.1. Leaf colour chart (LCC): Leaf colour chart are developed by the International Rice Research Institute to determine the N content of the leaves depending on their chlorophyll content at different growth stages. A standardized LCC has four panels with different colours from yellowish green to dark green. It is used to determine the quantity and timing of N fertilizer application to the crops mainly rice, wheat, maize etc. An LCC value of 4 indicates that there is 1.4 to 1.5 mg N / g leaf weight. The critical LCC values for HYV and basmati rice are 4 and 3 respectively. These values have to take from 7-10 DAS or 20-25 DAT to the heading stage of the crops. It is inexpensive and can be easily handled by the farmers.

Leaf colour chart

SPAD meter

4.2. Chlorophyll meter: The chlorophyll meter or SPAD (Subsystem Positioning Aid Device) meter instantly measures the chlorophyll content of the plant to determine optimum fertilizer dose required for the crop. It is a non-invasive, non-destructive method of measurement of indexed chlorophyll content reading of the plant in less than 2 seconds by clamping the meter over the green leafy tissue. From SPAD meter reading, the N status of the plant can be studied to formulate supplemental N recommendation if required.

4.3. Optical Sensors: Optical sensors are the electronics N management tools that include Green seeker, Rapid Scan CS-45 sensors. These tools emit a standard wavelength of light and measure the reflected light from the leaf coming back to the unit. Normalized difference vegetation index (NDVI) measurements made by Green Seeker optical sensor after applying one or two prescriptive doses of N and yield of the crop.

$$NDVI= (F_{NIR}- F_{RED})/(F_{NIR}+F_{RED})$$

Where, F_{NIR} and F_{RED} are respectively the fractions of emitted NIR and red radiation reflected back from the sensed area. The sensor outputs NDVI at a rate of ten readings per second. The NDVI value is compared with the N rate comparison strip that can provide plant condition which is helpful in predicting additional nitrogenous fertilizers. The sensor was passed at a height of nearly 0.9 m above the crop canopy and oriented so that the 0.6 m width was perpendicularly centered over the row.

5. Controlled and slow-release fertilizers: Use of slow-release fertilizers (SRFs) and controlled release fertilizers (CRFs) improve the NUE by slowly releasing the N over a longer period of time. The application of SRFs and CRFs decrease fertilizer use by 20-30% of the recommended dose without sacrificing the yield. These include chemical additives, biological inhibitors to constrain the activity of N in soil.

Leaching loss of NO_3^- can be managed by balanced application of N fertilizers, split application of urea synchronizing with crop demand, manipulation of water application and rooting depth, appropriate crop rotations and use of slow-release fertilizers and nitrification inhibitors like Dicyandiamide (DCD), N-serve (2-Chloro, 6-Chloro methyl pyridine), AM (2-Amino, 4-Chloro, 6-methyl pyrimidine) and neem-coated urea.

Apart from leaching loss, a part of the applied N fertilizers are lost from the soil by volatilization of ammonia and denitrification of N_2O and N_2 gas. Volatilization loss of

ammonia can be minimized by mixing of nitrogen fertilizers in soil rather than broadcasting on the soil surface as well as deep placement of urea super granules (USG) in the puddled rice field, using urease inhibitors like thiourea, methyl urea, phenyl phosphorodiamidate (PPD), ammonium thiosulphate etc. Some synthetic slow-release urea-based fertilizers viz., isobutylene diurea (IBDU) and crotobylidene diurea (CDU) and coated material like sulfur coated urea (SCU), gypsum coated urea (GCU), plastic coated urea (PCU), mud ball urea and may be used to reduce the rate of urea hydrolysis hence, decreasing NH_3 volatilization.

Nitrous oxide (N_2O) is produced by denitrification of NO_3^- under anaerobic condition mainly lowland rice fields which is a potent greenhouse gas that forces global warming. Denitrification loss can be minimized by decreasing the use of NO_3^- a form of N fertilizer (e.g. calcium ammonium nitrate, potassium nitrate etc.) in rice. It is beneficial to use nitrification inhibitors such as N-serve, DCD, AM etc., also deep placement of urea sugar granules (USG) in the traditional rice field is preferred along with efficient water management.

6. Green manuring: Inclusion of green manure crops mainly legumes in cropping systems purposes is a beneficial method to improve NUE. Cover crops and catch crops are most commonly used for green manuring. The advantages of green manuring are indicated by increased N availability and higher recovery of green manure N as legumes have the potential to fix atmospheric nitrogen. Yields of cereals following legumes are reported to be 30-35% higher than those following a cereal in cropping sequence. For example, 50-60 days old dhaincha, accumulates 4 to 5 t/ha dry matter or 100 to 130 kg/ha/N. It can be classified into two types:

a) In-situ green manuring: This is practice in which green manure crops are grown in field and later on they are buried in the same place.

Examples: Dhaincha (*Sesbania aculeata*), sunnhemp (*Crotolaria juncea*), lucerne (*Madicago sativa*) etc.

b) Green leaf manuring: Green leaves and twigs of plants are brought from outside and incorporated in the field.

Examples: Subabul (*Leucaena leucocephala*), karanj (*Pongamia pinnata*), *Glyricidia maculate* etc.

7. Integrated plant nutrient management: The greater losses of inorganic N fertilizers leading to environmental degradation and yield decline over a period of time. So, it is more obvious to improve productivity by substituting part of the inorganic fertilizers by organic sources of nutrients for the sustainability of the agro ecosystem. Organic sources of nutrients should not be the only choice to sustain the higher crop yield for meeting the food demand of a growing population. Therefore, combine use of inorganic fertilizers and organic sources of nutrients like manures, green manures, crop residues, biofertilizers etc. in a synergistic manner without compromising the yield is known as Integrated Plant Nutrient Management (IPNM) System.

Integrated plant nutrient management system sustains and improves the physical, chemical and biological health of the soil and enhances the availability of nutrients and reducing their losses. Besides, organic sources of nutrient act as SRFs that fulfill the

nutrient demand set by plants according to time and space. Application of N, half as urea and half as farmyard manure, resulted in higher fertilizer N recovery by Pusa Basmati-1 rice, higher retention of fertilizer in the soil and lower unaccounted for fertilizer N than sole urea application in sandy loam soil. Crop residues are left in the field after crop harvest that can be recycled for nutrient supply. Out of the nutrient taken up by cereals, on an average, 25% of N is retained in crop residues making them available sources of nutrients. The low decomposition rate because of high C: N ratio and immobilization of nutrients by cereal residues are some of the constraints in using them as a source of nutrients. The NUE is considered altered when N fertilizers are applied in combination with organic manures, green manures, crop residues and biofertilizers.

CONCLUSION

Nitrogen mainly found in tow basic forms namely organic and inorganic (NO_3^--N and NH_4^+-N). The N cycle consists of the processes like immobilization, mineralization, nitrification, fixation, plant assimilation, ammonia volatilization, leaching, denitrification by the action of microorganisms. Fertilizers NUE is very low in India i.e., 30-40% in rice and 40-60% in other crops as losses are accounted due to high mobility of N in the soil. To increase higher NUE, the most suitable types and rate of N fertilizers should be chosen at an appropriate time when it required by the crops. Application of SRFs and CRFs can potentially increase fertilizers use efficiency. Integrated plant nutrient management is an efficient approach to increasing NUE.

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