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Recent development programmes in the livestock sector of India

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The economic scenario in India is undergoing a sea-change, with Indian economy slated to be among the top three world economies by 2050 (NDRI vision 2050). The dairy sector that accounts for about 3.9% of the national GDP is an important means of livelihood security in the country. In the past two decades, with the manifestation of the continuous deceleration in rate of production growth of most of the food and non-food grain crops, the role of livestock sector, particularly that of dairy has become vital in maintaining the growth in agriculture sector. In its journey to the top position in the world in terms of milk production, the sector has witnessed several structural changes in production, processing and consumption that have been conditioned by the changing socio-economic environment in the country. The major issues concerned with livestock sectors are

- livestock production in India has been growing faster than crop production, and thus contributed towards sustaining agricultural growth. The growth in livestock production was driven by animal numbers and by higher productivity, but the effect of numbers outweighs that of productivity;
- Agricultural growth in general is poverty-reducing, but growth in livestock production is more pro-poor than a similar growth in crop production as livestock wealth is more equitably distributed than land;
- But, small-scale livestock producers are constrained by lack of access to markets, credit, inputs, technology and services which may deter them from taking advantage of the opportunities resulting from the expanding demand for animal food products in the domestic and global markets;
- Low level of public investment in the livestock sector is detrimental to the interests of millions of poor livestock producers;
- Value addition to livestock production is not encouraging and may constrain the growth of livestock production, especially amongst small-scale producers; and
- The paper argues for a conducive policy environment to enable poor households to secure livestock assets, inputs and technology and to improve their access to output markets.

To address these issues the Government of India has started many initiatives which are following

NATIONAL LIVESTOCK MISSION

The National Livestock Mission (NLM) has commenced from 2014-15. The Mission is designed to cover all the activities required to ensure quantitative and qualitative improvement in livestock production systems and capacity building of all stakeholders. The Mission will cover everything germane to improvement of livestock productivity and support projects and initiatives required for that purpose subject. This Mission is formulated with the objective of sustainable development of livestock sector, focusing on improving availability of quality feed and fodder. NLM is implemented in all States including Sikkim.

NLM has 4 submissions as follows:

The Sub-Mission on Fodder and Feed Development will address the problems of scarcity of animal feed resources, in order to give a push to the livestock sector making it a competitive enterprise for India, and also to harness its export potential. The major objective is to reduce the deficit to nil.

Under Sub-Mission on Livestock Development, there are provisions for productivity enhancement, entrepreneurship development and employment generation (bankable projects), strengthening of infrastructure of state farms with respect to modernization, automation and biosecurity, conservation of threatened breeds, minor livestock development, rural slaughter houses, fallen animals and livestock insurance.

Sub-Mission on Pig Development in North-Eastern Region: There has been persistent demand from the North Eastern States seeking support for all round development of piggery in the region. For the first time, under NLM a Sub- Mission on Pig Development in North-Eastern Region is provided wherein Government of India would support the State Piggery Farms, and importation of germplasm so that eventually the masses get the benefit as it is linked to livelihood and contributes in providing protein-rich food in 8 States of the NER.

Sub-Mission on Skill Development, Technology Transfer and Extension: The extension machinery at field level for livestock activities is very weak. As a result, farmers are not able to adopt the technologies developed by research institutions. The emergence of new technologies and practices require linkages between stakeholders and this sub-mission will enable a wider outreach to the farmers. All the States, including NER States may avail the benefits of the multiple components and the flexibility of choosing them under NLM for a sustainable livestock development.

RASHTRIYA GOKUL MISSION

"Rashtriya Gokul Mission" (RGM), aimed at conservation and development of indigenous bovine breeds, will be implemented as a part of Centrally Sponsored Scheme "National Programme for Bovine Breeding and Dairy Development".

Objectives of RGM

a) To undertake breed improvement programme for Indigenous Breeds so as to improve the genetic makeup and increase the stock.

b) To enhance milk production and productivity of Indigenous Bovines.

c) To upgrade nondescript cattle using elite indigenous breeds like Gir, Sahiwal, Rathi, Deoni, Tharparkar, Red Sindhi.
d) To distribute disease free high genetic merit bulls of indigenous breeds for natural service.

Activity components

(a) Strengthening of bull mother farms for conservation high genetic merit indigenous bovine Breeds.
(b) Assistance to Institutions/Institutes which are repositories of best germplasm.
(c) Implementation of Pedigree Selection Programme for the Indigenous Breeds with large population.
(d) Induction of disease free high genetic merit bulls of indigenous bovine breeds for natural service.
(e) Establishment of Breeder‟s Societies **(“Gopalan Sangh”).**
(f) Heifer rearing programme.
(g) Establishment of Field Performance Recording (FPR) in the breeding tract.
(h) Incentive to farmers maintaining elite animals of indigenous bovine breeds.
(i) Organization of Milk Yield Competitions.
(j) Award to Breeders‟ Societies **(“Kamadhenu”)**
(k) Establishment of Village level Integrated Indigenous Cattle Centres viz“Gokul Gram”: will be covered under the component “any other activity” related to cattle and buffalo development.
(l) Organization of Training Programme for technical and non technical personnel working at the Institutions engaged in cattle development.

Note : RGM is 100% Govt. Supported programme and implemented throughout the country by state implementing agencies (State Livestock Development Boards) during 12th Five Year Plan (2014-2017).

National Programme for Bovine Breeding and Dairy Development (NPBBD)

The National Programme for Bovine Breeding and Dairy Development (NPBBD) has been initiated in February 2014 by merging four ongoing schemes of the Department of Animal Husbandry, Dairying and Fisheries in the dairy sector, viz., National Project for Cattle and Buffalo Breeding (NPCBB), Intensive Dairy Development Programme (IDDP), Strengthening Infrastructure for Quality & Clean Milk Production (SIQ & CMP) and Assistance to Cooperatives (A-C).

This has been done with a view to integrate milk production and dairying activities in a scientific and holistic manner, so as to attain higher levels of milk production and productivity, to meet the increasing demand for milk in the country. The Scheme has two components (a) National Programme for Bovine Breeding (NPBB) and (b) National Programme for Dairy Development (NPDD).An allocation of Rs 1200.00 crore has been made available for implementation of the scheme during 12th Plan period.

Objectives of NPBBD

The mandate of the scheme is to:

a) To arrange quality Artificial Insemination services at farmers' doorstep;
b) To bring all breedable females under organised breeding through Artificial Insemination or natural service using germplasm of high genetic merits;
c) To conserve, develop and proliferate selected indigenous bovine breeds of high socio-economic importance;
d) To provide quality breeding inputs in breeding tracts of important indigenous breeds so as to prevent the breeds from deterioration and extinction;

National Dairy Plan Phase I (NDP I)

NDP is a Central Sector Scheme for a period of 2011-12 to 2018-19. NDP I is implemented with a total investment of about 2242 crore. Funding is through a line of credit from the International Development Association (IDA), which along with the share of the Government of India will flow from DADF to NDDB and in turn to eligible EIAs.

Objectives

NDP I is a scientifically planned multi-state initiative with the following Project Development Objectives :
a) To help increase productivity of milch animals and thereby increase milk production to meet the rapidly growing demand for milk.
b) To help provide rural milk producers with greater access to the organised milk-processing sector.
These objectives would be pursued through adoption of focused scientific and systematic processes in provision of technical inputs supported by appropriate policy and regulatory measures.

Components and sub components

A. Productivity Enhancement (aims at increasing bovine productivity through a scientific approach to animal breeding and nutrition)
B. Village based milk procurement systems for weighing, testing quality of milk received and making payment to milk producers
C. Project Management and Learning (effective coordination of project activities among various EIAs, timely preparation and implementation of annual plans, regular review and reporting of project progress and results, a comprehensive and functional project management information system (MIS) and learning that will support improvement and innovation.)

Project Area

NDP I will focus on 18 major milk producing states namely Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal, Telangana, Uttarakhand, Jharkhand and Chhattisgarh which together account for over 90% of the country's milk production. Coverage of NDP I will however be across the country in terms of benefits accruing from the scheme.

Projects & Operations

The projects and operations under NDP I are aimed at increasing the productivity of milch animals and improving the market access of milk producers in the project area. These objectives would be pursued through: (a) adoption of scientific and systematic processes in provision of technical inputs and services to milk producers at their doorsteps; and (b) facilitating access of milk producers to the organized milk processing sector.

The key principles underlying the project design are:

a) A dairy farmer-centric approach.

b) Improving quality of inputs and services delivered to farmers – through adoption of common protocols and Standard Operating Procedures (SOP) in provision of technical inputs and other services at the farmer's doorstep.

c) Enhancing market access for sale of surplus milk by milk producers -- through village level institutional structures operating in a fair and transparent manner.

d) An enabling policy and regulatory environment to support implementation of project investments.

(In order to meet the growing demand for milk with a focus to improve milch animal productivity and increase milk production, the Government has approved National Dairy Plan Phase-I (NDP-I) in February, 2012 with a total investment of about Rs.2242 crore to be implemented from 2011-12 to 2016-17. NDP-I will help to meet the projected national demand of 150 million tonnes of milk by 2016-17 from domestic production through productivity enhancement, strengthening and expanding village level infrastructure for milk procurement and provide producers with greater access to markets. The strategy involves improving genetic potential of bovines, producing required number of quality bulls, and superior quality frozen semen and adopting adequate bio-security measures etc. The scheme is implemented by NDDB through end implementing agencies like state Dairy Cooperative Federations/Unions/Milk Producers Companies. NDP-I would focus on 15 major milk producing States - Uttar Pradesh, Punjab, Haryana, Gujarat, Rajasthan, Madhya Pradesh, Bihar, West Bengal, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Orissa and Kerala which account for over 90% of the country's milk production. Now the area of Operation of NDP-I has been extended to three more states i.e.Uttarakhand, Chhattisgarh and Jharkhand. Coverage of NDP- I will however be across the country in terms of benefits accruing from the scheme.)

PASHUDHAN SANJIVNI

Animal Wellness Scheme 'Pashudhan Sanjivani'- Health Cards, Tagging, Health Services at door step.

Reason behind starting of this programme:

(i) At present 85 million animals are in milk while records on breeding, productivity, treatment and vaccination are not properly maintained by State Animal Husbandry Departments as system for maintaining records on the above aspects is not yet evolved in the country.

(ii) Due to absence of records on animal identification and traceability it is not possible to separate healthy animals/animal products obtained from healthy animals and diseased animals/products obtained from diseased animals. This is Major cause of concern with regard to spread of diseases among animal population and spread of zoonotic diseases among human beings.

(iii) Most of the veterinary hospitals and dispensaries are stationary and veterinary services are not available at farmers' doorstep.

(iv) Emergency facility in the form of dedicated helpline is not available to livestock owners.

(v) Country is facing difficulty in expanding trade of livestock and livestock products as we have not established animal identification and traceability to meet sanitary and phytosanitary (SPS) requirements.

Features of Pashu Sanjivani

- Nakul Swasthya Patra (Health cards),
- Tagging (Animal identification and traceability using polyurethane tags with unique identification number -UID)
- Emergency Help Line for farmers
- MAITRIs delivery of services at Farmers doorstep

Major Outcomes:

Major outcomes of the scheme will be: i) Control on spread of animal diseases; ii) Scientific management of animals iii) enhanced production and productivity; iv) improvement in quality of livestock & livestock products and v) increase in trade of livestock and livestock products by meeting out SPS issues.

"E- Pashudhan Haat":

An e- market portal for bovine germplasm for connecting breeders and farmers

Reason behind starting of this programme:

(i) At present there is no authentic market in the country for quality- disease free germplasm in the form of: i) semen; ii) embryos; iii) calves; iv) heifers and v) adult bovines available with different agencies/stake holders.

(ii) Most of the animals are sold in unorganized markets controlled by middlemen. Poor quality of germplasm with unknown genetic merit and disease status is usually sold in this market.

(iii) Breed wise information on availability of bovine germplasm is not available which is essential for promotion of indigenous bovine breeds. Nakul Swasthya Patra and UID will be made mandatory for sale of bovine germplasm through E- Pashu Haat.

Major Activities:

Major activities for creating electronic platform for trading of bovine germplasm are i) creation of *"E- Pashudhan Haat":* an e- market portal for bovine germplasm; ii) connecting breeders state agencies and stake holders with *"E- Pashudhan Haat*" iii) real time data on availability of germplasm uploaded periodically; and iv) maintaining identification and traceability of germplasm sold through e market.

Major Outcomes:

Major outcomes of the scheme are: i) propagation of quality controlled germplasm; ii) availability of disease free germplasm with known genetic merit iii) price evaluation available to buyer; iv) one stop portal for bovine breeders v) no involvement of middlemen in sale and purchase of animals vi) sale only of tagged animal with animal wellness card vii) propagation of indigenous bovine breeds in the country vii) increase in milk production and productivity

PASHUDHAN BIMA YOJANA

Pashudhan Bima Yojana is a new insurance scheme launched by the Government of Haryana. Under the scheme, state government will provide insurance cover to cows, buffaloes, bulls, camel, sheep, goat and pig for a period for three years. Under the Pashudhan Bima Yojana, different premium is charged for different animals. The insurance cover would be provided for three years. The premium under the Pashudhan Bima Yojana will be Cows, Buffaloes, Bulls, Camel – Rs. 100 Sheep, Goat, Pig – Rs. 25. The scheme is free of cost for cattle breeders belonging to Scheduled Castes. Under the scheme, the insurance companies will pay the compensation in case of death of the animal. Animal Husbandry and Dairying Department of Haryana Government is planning to cover one lakh cattle under Pashudhan Bima Yojana.

Vitamin deficiency diseases of poultry

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Poultry occupies a unique position in the livestock economics and it is one of the fastest growing segments of the agricultural sector in India. India's total poultry production comprises of 94.98% chicken, 3.23% duck, 1.79% turkey and others. India occupies 3rd position in egg and 5th position in poultry meat production on the world poultry map. Poultry is expected to play the most crucial role in transforming the nutritional demography of India with ever growing share of protein based cheap human diets. Poultry egg and meat are considered to be cheapest source of animal protein. So to have a healthy stock much emphasize is to be taken on the nutritional requirement.
Nutritional deficiencies can occur in several ways:-

i. Dietary insufficiency
ii. Inhibition of absorption / utilization
iii. Metabolic abnormalities

Vitamins deficiencies is one of the common among the nutritional deficiencies as poultry sectors pays less importance in assembling the balance feed nutrition for poultry.

All recognized vitamins are essential for poultry but Vitamin C is not dietary essential for poultry, as it is synthesized in adequate quantity. Special attention is needed for Vitamin A, Vitamin D and Riboflavin.

COMMON VITAMIN DEFICIENCY DISEASES

NIGHT BLINDNESS

It is caused by deficiencies of Vitamin A as this vitamin is the most challenging of all the vitamins, because it is most likely to cause deficiency in poultry.
Its main function is to maintaining normal vision in reduced light as its main component is retinol which is required for the synthesis of rods, any deficiency may lead to this disease.

Symptoms :- near sightedness, or blurred vision when looking at faraway objects, cataracts, or clouding of the eye's lens retinitis pigmentosa, which occurs when dark

pigment collects in your retina and creates tunnel vision. Further deficiency persist lead to keratinization of conjunctiva and inadequate lubrication of cornea leads to **Xeropthalmia** (dryness of eye).

Treatment :- Severely deficient poultry should be given vitamin A preparation at a level of about 10,000 IU/ kg of feed this should be given in advance stages once disease is stabilized it is permanent.

NUTRITIONAL ROUP

It is also caused by deficiency of Vitamin A as its primary function is to maintain the epithelial structures (mucous membranes) of body any deficiency will lead hard and dry squamous epithelium which is known as **squamous metaplasia**.

Symptoms:- Squamous metaplasia blocks the ducts of mucous glands specially of respiratory tract which leads to nasal discharge, development of small white pustules, there is gluing of eye lids.

Treatment:- Severely deficient poultry should be given vitamin A preparation at a level of about 10,000 IU/ kg of feed. Addition of anti-oxidants in diet

GLUING OF EYELIDS

RICKETS & OSTEOMALACIA

It is caused by deficiency of Vitamin D as it is required for maintenance of normal level of Calcium and Phosphorous in blood, it also controls there absorption from large intestine. Its main function is to mineralize bone and provide strength. This vitamin jointly works with parathyroid hormone in removal of calcium from bones.

Excess use of Sulpha drugs may interferes with the absorption of vitamin D3.

Symptoms:- Rickets(reduced deposition of minerals) is a disease of young while osteomalacia (loss of minerals) is a disease of adult. Deformity develops in legs with pain, hard swelling and lameness. Hock joints, head of ribs at costo-chondral junction become enlarged. Bones, beak, shank and claw become soft and rubbery, extreme leg weakness (osteoporosis). Egg production decease with thin shelled eggs.

Treatment :- feeding a single large dose of 1500 IU of Vitamin D3 by mouth cures rickets more quickly compared to adding it to diet. In advance cases injection of Vitamin D @ 50 IU/kg b.wt in chicks and double dose in hens.

RUBBERY BONE

ENCEPHALOMALACIA (Crazy chick disease)

It is a deficiency disease of Vitamin E. It contains alpha tocopherol which is an important antioxidant that primarily protects cells from damage associated with oxidative stress caused by free radicals. The brain is highly susceptible to oxidative stress, which increases during ageing and is considered a major contributor to

CRAZY CHICK DISEASE

neuron degeneration.
It is mostly seen in birds of age 5 weeks.
Symptoms :- muscular weakness, progressive muscular in-coordination with frequent falling, backward or downward retraction of head , rapid contraction of legs, torticollis, paralysis and death.
Treatment :- Vitamin E is given through drinking water. Single dose of 300 IU P.O orally is given. Selenium can also have some preventive effect.

- **EXUDATIVE DIATHESIS**

It is caused by deficiency of Vitamin E as it is a fat soluble antioxidant inside the cell main function of it is to protect the cell membranes and maintain the permeability of blood vessels.
Symptoms:- capillary walls become abnormally permeable and subcutaneous edema develops. This edema is often located along the ventral of the thorax, abdomen, and under the mandible. The edema may appear to have a slightly greenish-blue color, due to the hemoglobin breakdown of the leaking red blood cells. If extensive edema develops, birds may have difficulty walking and may stand with their legs spread apart.
Treatment:- :- Vitamin E is given through drinking water. Single dose of 300 IU P.O orally is given. Selenium can also have some preventive effect.

EXUDATIVE DIATHESIS

- **Muscular dystrophy**

Deficiency of Vitamin E causes this disease as cell membranes are not maintained, thrombosis of blood vessels cause blockage which leads to degeneration and necrosis of muscles fibers.
Symptoms:- mostly breast and thigh muscles are affected, there is paleness of muscles with white streaks.
Treatment:- :- Vitamin E is given through drinking water. Single dose of 300 IU P.O orally is given. Selenium can also have some preventive effect.

PEROSIS

It is caused by deficiency of Pantothenic acid Niacin, Biotin, Folic acid, Choline, Vitamin B12.
Symptoms:- It is characterized by retarded growth of long bones, widening of the tibio-metatarsal joint, twisting or bending of the distal end of tibia and the proximal end of metatarsus and finally, slipping of the gastrocnemius muscle tendon from its condyles. Clinically, it is manifested by impaired locomotion because of leg lateral and posterior malposition of the leg.

PEROSIS

Treatment:- Orally/injection of Pantothenic acid @ 10 mg/kg diet can prevent the deficiency. Choline chloride in diet along with folic acid and Vitamin B12 is recommended.

STARGAZING/OPISTHOTONUS

It is caused by deficiency of Vitamin B1 (Thiamine) as it is a precursor for many enzymatic reactions. High carbohydrate feed is less in vitamin B1.

Symptoms:- it is characterized by flexed legs and drawback of its head(paralysis of anterior muscles of neck). Chick will soon loses its ability to stand or sit up right , fall on floor, where it lie down with its head still drawn back.

Treatment:- Vitamin B1 P.O @ 0.8- 1.8 mg/kg feed should be given.

STAR GRAZING

CURLED TOE PARALYSIS

It is caused by deficiency of Vitamin B2 (Riboflavin). It serve as a cofactor for many enzymes these enzymes participate in metabolism any deficiency also affect the nervous system as it is required for proper transmission of nerve impulse.

Symptoms:- degeneration of peripheral nerves mostly sciatic nerves cause leg paralysis, chick is unable to walk or stand, sit on hock and toes are curled inwards.

Treatment:- 100 micro g in 2 dose + incorporated in ration,3.6 mg/kg for chicks

1.8 mg/kg for grower, 2.2 mg/kg for layer.

CURLED TOE PARALYSIS

CONCLUSION

Poultry is the upcoming sector in Indian economy. The main problem in poultry production is the feed formulation as inadequate nutrition cause heavy losses of flocks. Vitamin is a major portion of feed though required in small quantity but if deficient can cause severe loss to both flocks and farmers. So for preventing these diseases to occur addition of vitamin supplement in ration can solve a problem to a great deal.

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Spectral quality and physiological responses in plants

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PLANTS AND SPECTRUM

Light is one of the most important environmental factors, acting on plants not only as the sole source of energy, but also as the source of external information, affecting their growth and development. Visible light ranges from low blue to far-red light and is described as the wavelengths between 380 nm and 750 nm, although this varies between individuals. The region between 400 nm and 700 nm is what plants use to drive photosynthesis and is typically referred to as Photosynthetically Active Radiation (PAR). The effects of different wavelengths on plant function and form are complex and are proving to be an interesting area of study for many plant scientists.

Plants have evolved under broadband spectra and are exposed to spectral differences under natural conditions dependent on weather conditions, time of day, season, and their growth environment. Many spectral responses of plants are regulated via photoreceptors, such as phytochromes, cryptochromes, and phototropins, which alter the expression of a large number of genes. These numerous and complicated spectrum-regulated plant responses have been, and remain, the subject of extensive study.

IMPORTANCE OF DIFFERENT SPECTRA

Ultraviolet light (10nm-400nm)

UV light is a very important contributor for plant colors, tastes and aromas. This is an indication of near-UV light effect on metabolic processes. Studies show that 385 nm UV light promotes the accumulation of phenolic compounds, enhances antioxidant activity of plant extracts, but does not have any significant effect on growth processes.

Blue light (430nm-450nm)

Blue (400-500 nm) light is also important for the synthesis of chlorophyll, chloroplast development, stomatal opening and photomorphogenesis. The 450nm spectrum enables cryptochromes and phototropins to mediate plant responses such as phototropic curvature, inhibition of elongation growth, chloroplast movement, stomatal opening and seedling growth regulation. It affects chlorophyll formation, photosynthesis processes, and through the cryptochrome and phytochrome system, raises the photo morphogenetic response. These wavelengths encourage vegetative

growth through strong root growth and intense photosynthesis and are often used as supplemental light for seedlings and young plants during the vegetative stage of their growth cycle, especially when "stretching" must be reduced or eliminated.

Green light (500nm-550nm)

The co-action of green light and other light wavebands provides a strategy for a plant to precisely tune its morphology to adapt to changing light environments. Green light is sometimes used as a tool for eliciting specific plant responses such as stomatal control, phototropism, photomorphogenic growth and environmental signaling. Green light acts similarly to blue light to inhibit dormancy release in the absence of blue light.

Red light (640nm-680nm)

Red light affects phytochrome reversibility and is the most important for photosynthesis, flowering and fruiting regulation. Phytochrome, and its central role in photoregulation of plant development, has been the subject of extensive study for over 60 years. These wavelengths encourage stem growth, flowering and fruit production, and chlorophyll production. Red spectrum is most effective for photoperiodic extension or night interruption to induce flowering of long-day plants or to prevent flowering of short-day plants. Most energy-efficient source for photosynthesis among all available supplemental LEDs is red.

Far red (730nm)

Although the 730nm wavelength is outside the photosynthetically active range, it has the strongest action on the far-red absorbing form of phytochrome, converting it back to the red-absorbing form.

MANAGEMENT OF SPECTRUM

Lighting requirements typically fall into three general categories:

- Propagation and transplant production that involve both photosynthetic and photomorphogenic lighting;
- Photoperiodic lighting to induce early or out-of-season flowering;
- lighting to enhance photosynthesis for crop production, especially during light-limited periods of the year.

The light plays an important role in photosynthesis, growth and morphogenesis of plants that depends of the wavelength in addition to being one of the variables that affect the concentration of phytochemicals on them. For this reason the supplemental lighting systems used for crops in controlled environment are an important factor, because they determine the cost and nutritional quality of greenhouse vegetables, so that technological advances that may arise in this area are valuable. Spectral management can be achieved by two means i.e, with the use of shade nets or with artificial lighting. Natural sunlight invariably provides more light than photosynthesis can utilise and plants expend energy in dissipating potentially phototoxic light. In contrast, LEDs can be tuned to provide the irradiance and wavelengths that are most biologically appropriate for yield and crop quality without exceeding the photosynthetic saturation. Traditionally, high pressure sodium lamps, fluorescent and incandescent lamps of different spectral emissions have been used for these purposes, but these

devices of light have certain limitations, such as its short lifetime, high power consumption and heat emission . The LED (light emitting diode) is a solid state light source, durable and narrow band that can be used in a variety of horticultural applications, as lighting system in greenhouses, growth chambers and research on plant growth in space. Incandescent lamps, which are low in R:FR ratio, frequently lead to stem elongation while fluorescent sources, which are high in R:FR ratio, produce short and compact plants. Radiation filters, both liquid and rigid, for improving greenhouse crop productivity and reducing greenhouse temperature gained attention in the 1970s and considerable progress has been made since then.

At the present time, LED technology has had a great development, with the use of new base materials, such as aluminium indium gallium phosphide (AlIn-GaP) and indium gallium nitride (InGaN), among others. This has allowed the development of high-intensity LEDs with power outputs from 1 to several tens of watts . The benefits that this technology brings are greater light intensity, lower energy consumption (energy cost savings of 40%), increased device longevity compared to other lighting systems, increasing the speed switching, better color control and is a device that can be environmentally friendly because it does not use toxic gases, such as fluorescent lamps and mercury.

APPLICATIONS OF SPECTRAL MODIFICATION

Spectral modifications can be utilized for ornamental propagation and vegetable propagation. Flowering of many specialty crops, especially ornamentals, is hastened under a particular photoperiod. To induce flowering for predetermined market dates, photoperiod is commonly modified using low-intensity (photoperiodic) lighting. Incandescent lamps have been a common choice to deliver photoperiodic light because of their efficacy and low purchase cost. LEDs containing Red (R) and Far Red (FR) light will be as or more effective than conventional light sources at inducing flowering of plants with a photoperiodic flowering response, while growers will benefit from reduced operating and maintenance costs, increased durability, etc. Supplemental lighting is needed for greenhouse vegetable propagation during winter when DLI (Daily Light Integral) is a major factor limiting transplant production. The dose of FR needed to induce maximum hypocotyls elongation for grafting is saturated at 2-4 $mmol.m^{-2}.d^{-1}$. End-Of-Day (EOD) lighting with LEDs will allow specific spectral and dose requirements to be defined for FR to extend rootstock hypocotyls for better grafting, as well as to prevent seedlings from becoming too leggy. It also was demonstrated that moving LED fixtures for EOD lighting are as effective as stationary fixtures.

CONCLUSION

Using appropriate illumination systems allows control of light variable as factor controlling growth and morphogenesis in plants. The light is manipulated to improve the quality and production of plants in greenhouses. and high intensity LED light could be an alternative to improve performance in this type of agriculture.

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Hydroponics: Livelihood option for Urban Areas

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Abstract

Hydroponics is the science of soilless growing of plants nutrient rich solutions with very little water. It is a technique where the physiological requirements of plants can be met without use of soil or natural sunlight. Hydroponics techniques have proven it to be very useful and efficient for producing food for livestock. The food obtained by this technique, is free from undesirable materials such as weeds, insects, dust, insecticides, germicides, carcinogens.

INTRODUCTION

The term hydroponics derived from Greek "*hydros*" meaning water, and "*ponos*" meaning work. It can sometimes be mistakenly referred as aquaculture, oraquiculture, but these terms are really more appropriately used for other branches of science that have nothing to do with gardening.

Hydroponic growing (as opposed to soil growing) allows controlling the nutrient levels for plants directly. Because of the higher control over nutrients, hydroponically grown plants generally have a much higher yield than similar plants grown in soil. This is simplest and oldest method for soilless culture which is represented like vessel of water in which inorganic chemicals are dissolved to supply the nutrients that plants require. Various modifications of pure solution culture have occurred in the past. The retention of nutrients and water can be further improved through the use of spaghnum peat, vermiculite, or bark chips.

History

Between the 10thand 11thcenturies, the Aztecs developed a hydroponics based system of floating gardens. Instead of their land, they settled at Lake Tenochtitlan. It was very difficult to grow crops on marshy shore of the lakes; they developed rafts from the reeds and roots. These rafts were topped with a bit of soil from the bottom of the lake, and then floated out to the centre of the water (Thakur *et al.,* 2016). Crops would grow on top of the rafts, their roots reaching through the rafts and down into the water. Marco Polo's writings indicate, he witnessed similar floating gardens while visiting China in the late 13th century. In 1699, another English scientist, John Woodward, performed tests involving spearmint growth in various water solutions. He attempted to grow spearmint plants in rain water, river water and water that had been mixed with soil and

then drained. He found that the mint grew faster and produced healthier plants in the water solution that had been mixed with soil. His conclusion was that plants would grow better in less pure water than they would in distilled water (Thakur *et al.,* 2016).

The hanging garden of Babylon is also a fine example of soilless culture. In India, Hydroponics was introduced in year 1946 by an English scientist, W. J. Shalto Duglas and he established a laboratory in Kalimpong area, West Bengal. He written a book on Hydroponics, named as 'Hydroponics-The Bengal System' (Thakur *et al.,* 2017).

PRINCIPLES THAT DRIVEN HYDROPONICS

A plant gets its food source by turning CO_2, light and water (or hydrogen) into carbohydrates through a process called photosynthesis. With hydroponics growing, plants are grown without soil so they must get their nutrients from the nutrient solutions added to water. The absence of soil in growing means that hydroponics systems must have some way of supporting the plants while still allowing the bare root system maximum exposure to the nutrient solution. Often a "growing medium (as substrate)" is used for support and to aid in moisture and nutrient retention in hydroponics growing. Because they lack media to store water and nutrients, water culture systems need a continuous flow of nutrients to prevent drying out the plant roots.

Plants need an energy source in order to grow. With hydroponics growing this energy may come from natural light, which has the full spectrum of colour or through the use of different types of artificial lighting (grow lights), which can be selected for specific plant varieties and optimum plant growth characteristics.

Growing Substrates

1. Pea Gravel
2. Coarse Sand
3. Sawdust
4. Perlite
5. Vermiculite
6. Peat moss
7. Rockwool
8. Expanded clay pellets
9. Grow stones
10. Coconut fibre
11. Oasis cubes
12. Sphagnum moss

Table: Difference between hydroponics and field production system

Hydroponics	Field production
➢ No soil is required.	➢ Good top soil is required. ➢ Good soil = good drainage, compost, disease-free.
➢ Plants are irrigated automatically.	➢ No water stress. ➢ Plants need to be irrigated to minimise water stress
➢ Plants are irrigated automatically.	➢ No water stress. ➢ Plants need to be irrigated to minimise water stress

➢ Nutrients are available at all times ➢ Only soluble fertilizers are used. ➢ Hydroponic fertilizer formulations contain balanced nutrient content	➢ Nutrients must be added to soil. ➢ Unless a laboratory analysis is done, too ➢ much or too little nutrients can be added
➢ Soil borne diseases can be eliminated	➢ Soil borne diseases can build up in the soil.
➢ Hydroponic production is not organic because artificial nutrients are always used and plants are usually not grown in soil.	➢ It is possible to produce organic vegetables in soil because one can use organic fertilizers such as compost and manure.

Advantages of using hydroponics over soil culture

1. Crops can be produced on non-arable land (not fit for farming):

- ❖ Land with poor soils, and contamination (i.e., high heavy metal and salinity levels).
- ❖ The grower doesn't have to have good soil since the systems; bags, etc. are placed on top of the ground.

2. Isolation from diseases or insect pests usually found in the soil.

- ❖ The plants roots are contained in systems, bags, etc. and do not grow through soil that might contain diseases or other pests such as insects and nematodes.
- ❖ Additionally, white fabric ground covers can be placed on the greenhouse floor to further isolate the systems and plants from soil-borne pests.

NOTE: The white fabric also reflects light back up into the canopy enhancing photosynthesis, allows for ease of cleaning and helps control humidity and weeds.

3. Direct and immediate control over the rhizosphere.

- ❖ Since the roots are either growing in water or growing through an inert medium, whatever is in the nutrient solution is bathing the roots. Therefore, nutrient concentrations and pH can be adjusted quickly.

4. High planting densities are possible which minimizes use of land area:

- ❖ For field tomatoes a typical planting density is 4000 to 5000 plants per acre whereashydroponic tomatoes can be accommodates approx. 10,000 to 11,000 plants per acre.
- ❖ Plants can be grown closer together because of the use of indeterminant ("vining") varieties that take up less area than do bush varieties usually used forfield cropping. Also they need less root room – the plants are "spoon fed" the nutrient and water they need and do not have to grow a large root system to find these, as field tomatoes do in the soil.

5. Higher yields are possible:

- ❖ Because of higher planting densities, higher yields are also possible. Also, indeterminant varieties, bred for the greenhouse, can produce over 6-12 months. And since most commercial hydroponic production takes place within greenhouses production, through the use of inter-planting, can occur year around.
- ❖ Yields are also greater due to better control over water, nutrition, EC, pH and diseases.

6. Efficient use of water and nutrients:

- ❖ In soil culture water may be lost in wetting the soil beyond the reach of the plant roots or from the surface through evaporation.
- ❖ In hydroponic culture, since the nutrient solution is enclosed in a bag, tube, etc., there is no loss and little or no water stress in the plant.

7. Ease of cleaning the systems:

- ❖ The aggregate growing media can be steam sterilized, or simply replaced.
- ❖ Whole systems, including the drip irrigation system, can be quickly sterilized using 10% bleach and cleaned of salt build-ups using a mild acid (rinse well).

8. No weeding or cultivation is needed.

9. Transplanting of seedlings is easy with no transplant shock:

- ❖ In soil culture the root mass can be easily disturbed during transplanting causing root breakage, plant stress and stunted growth for up to a week.
- ❖ In hydroponic culture seeds are started in Rockwool cubes or plugs, and then transplanted into larger cubes with holes made for that purpose. There is no disturbance of the root mass, little or no root breakage and therefore minimal plant stress and transplant shock.

10. Fruit of hydroponically grown plants can have more flavour:

- ❖ Hydroponically grown vegetable, are picked after they have begun to ripen, which includes the typical red colour formation of the fruit. The grower can also raise the EC (electrical conductivity measuring salt levels in the root zone that tends to stress the plant and enhance fruit flavour.
- ❖ Tomatoes from field grown plants (in many areas) are picked “green”, then “gassed” with ethylene which induces lycopene formation but does not enhance the flavour. Therefore, you get nicely coloured fruit with little or no taste.

Types of Systems

1. Basic wick
2. Non-circulating raft system or deep water
3. Raft or floating system
4. NFT (nutrient film technique)
5. Ebb and Flow
6. Top feed/Drip

1. **Basic wick:** This type is the most simple hydroponics system. It belongs to the so called passive systems and is based on the capillary force that does not require

any mechanism (Fig. 5). Nourishment is delivered to the roots with the help of wicks going from the tank to the substrate. This system is used for the ornamental gardening with normal soil (one end of the wick is placed into the water or special solution and the other one is in the pot with soil). This system has one and rather important drawback: it works only for relatively small plants. Big and hygrophilous plants need more nutrient solution than they can get from filters (Thakur *et al.,* 2016)

2. **Non-recirculating ("air-gap") system:** The roots hang into a nutrient solution reservoir, with the upper part of the root mass suspended in air (air roots to take up needed oxygen) and lower part of the root mass in direct contact with the nutrient solution (water and nutrient roots) (Fig. 2).
3. **Raft or floating system:** Plants are suspended through Styrofoam boards which float on the surface of the nutrient solution. Oxygen must be supplied to the roots using an aquarium pump and air stones or a '*venturi*' system. If large Styrofoam cups, filled with perlite or other media, are used, and positioned so that most of the cup is out of the solution, no pump is needed (Fig. 3).
4. **Nutrient film (flow) technique (NFT):** The roots may be growing from Rockwool blocks or through cups filled with an aggregate for support but ultimately hang into a slightly slanted tube or trough. The nutrient solution is pumped to the higher end, flows past the hanging roots and then back to the reservoir (Fig. 4).
5. **Ebb and flow (flood and drain) system:** The roots grow down through an aggregate. The nutrient solution is pumped into the aggregate medium, floods the root zone for a short time, and is then allowed to drain back into the reservoir (Fig. 5).
6. **Top Feed/Drip Systems:** The roots grow down through an aggregate. The nutrient solution is delivered to the top of the aggregate medium, percolates through and then either drains to waste or is re-circulated into a reservoir (Fig. 6).

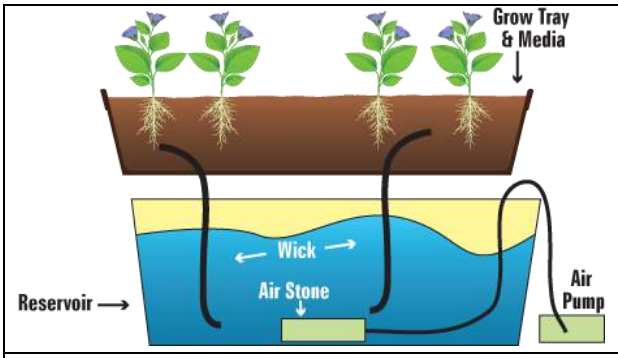

Fig 1. Basic wick (Source: https://www.hummert.com/newsletter/volume-22/why-hydroponics)

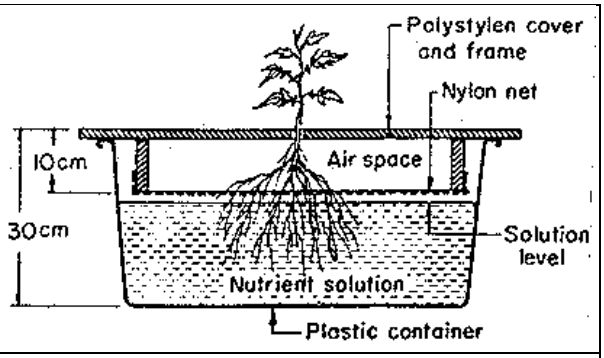

Fig 2. Non-recirculating ("air-gap") system (Source: http://www.nzdl.org/gsdlmod)

Fig 3. Raft systems or Deep water culture (Source: http://aquaponichowto.com)

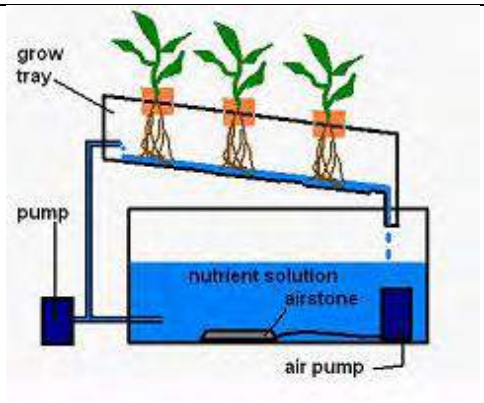

Fig 4. Nutrient Film Technique (Source: www.diy-guides.com)

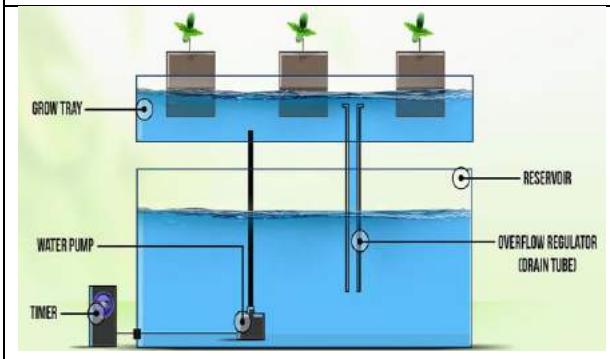

Fig 5. Ebb and Flow (Source: https://greencamp.com/ebb-and-flow)

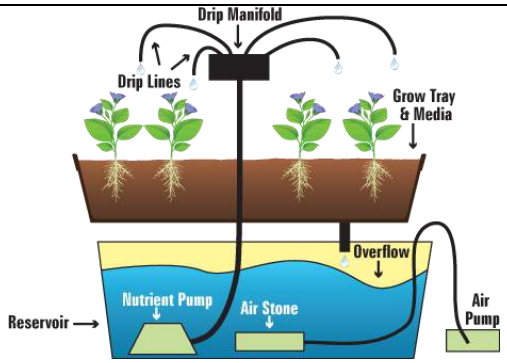

Fig 6. Top Feed/Drip Systems (Source: https://www.hummert.com/newsletter/volume-22/why-hydroponics)

Suitable crops for hydroponics

According to Singh and Singh (2012), the following crop can be growing without any hinders:

1. Vegetables - Tomato, Chilli, Brinjal, Green bean, Beet, Bell pepper, Cabbage, Cauliflower, Cucumbers, Melons, Radish, Onion, Lettuce
2. Condiments - Parsley, Mint, basil
3. Flower / Ornamental crops - Marigold, Rose, Carnations, Chrysanthemum
4. Medicinal crops - Aloe Vera, Coleus
5. Fruits – Strawberry

CONCLUSION

Hydroponics is a technology that provides option for the production of vegetables and flowers under limited area. The technology is suitable for urban areas where the vegetables in kitchen garden are not possible to grow. This can be produce sufficient vegetables for one family in a limited time. The quality of produce under hydroponics is good and free from the direct contamination of agro-chemicals. Under this system, the green fodder for animal can also be produce. It has more advantageous over field

system of crop production with respect to the easy handling and maintenance, quality of produce and also free from pesticides.

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Management strategies for clean milk production

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At present dairy farming is fast growing industry. For successful dairy farming, farmers must not only recognize the value of good clean milk but should also know how to produce it as well. Good milk and good dairy products are acknowledged to be in great demand, and each brings fair financial returns. The health requirements for milk are also becoming more rigid every year, and it is up to the dairymen to produce milk of better quality to meet these requirements. People are being encouraged to use more dairy products. So, it is important that milk should come from clean herds and clean stables, and should be handled right all along the line. Since the beginning of the dairy industry one of the big difficulty is obtaining clean milk. Therefore, by applying the best management strategies at farm, the ill effect of impure milk can be overcome and wholesome as well as superior milk quality can be produces and maintained.

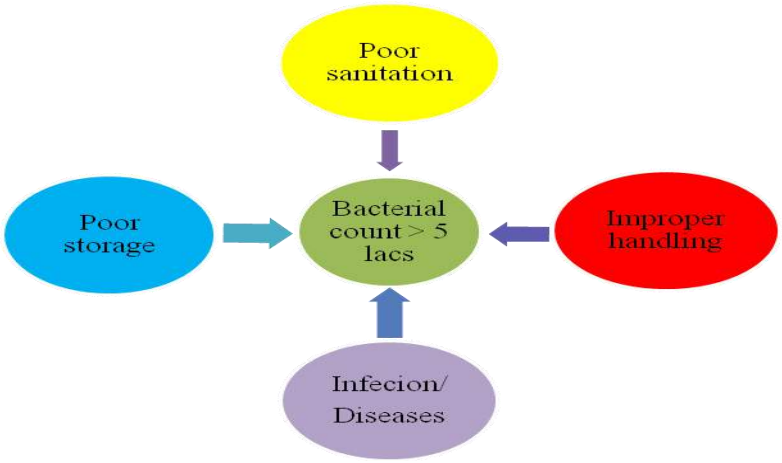
INTRODUCTION

India has emerged as the highest milk producing country in the world which accounts for 18.5 % of world production, achieving an annual output of 146.3 million tonnes during 2014-15 as compared to 137.69 million tonnes during 2013-14 and recording growth of 6.26%. The per capita availability of milk in India has increased from 176gms per day in 1990-91to 322 gms per day by 2014-15. It is more than the world average of 294 gms per day during 2013. Although India ranks first in the milk production, clean milk production is a challenge for it due to lack of technical knowledge to the farmers and pricing policy of milk. Dairy innovations are not adopted on mass scale by dairy farmers due to lack of extension services and due to non - adoption of hygienic milk production practices by the dairy farmers quality of milk produced is compromised. Hence, both pre and post secretory management of milk at farm level should be focused upon for the controlling of
quality of milk and production of clean milk.

Clean milk refers to "Milk coming from healthy milch animal possessing normal flavour, devoid of dirt and filth, containing permissible limit of bacteria and essentially free from adulterants, pathogens, various toxins, abnormal residues, pollutants and metabolites".

Raw milk quality encompasses criteria relating to composition (fat, protein, lactose milk solids etc.) and hygiene [Somatic cell count (SCC) and total bacterial count]. SCC is an index of udder health and milk quality. An udder quarter is considered healthy if it has SCC<100,000 cells/ml and is free from mastitis pathogen. The total bacterial count should be lower than 3 million/ml or otherwise, it will lead to significant degradation of the fat, protein and lactose causing off-flavour and would significantly reduce the flexibility in processing the milk. Although pasteurization reduces the bacterial count, it cannot destroy the bacterial spores which germinates again. Moreover there are some bacteria producing toxins that survive even at pasteurization temperature and remain in the milk products too. Practically all the changes that take place in milk, from the time it is drawn until consumed, are due to the action of microorganisms.

Causes of Bacterial Load in Milk



Various pathogens responsible for undesirable changes in milk are –

Pathogens	Undesirable changes in milk
Streptococcus liquifaciens	Rapidly coagulates and proteolysis milk at low acid level due to rennin.
Bacillus coagulaus and *B. collidolactis*	They are heat resistant spore forming bacteria survive pasteurization, grow at high temperature and curdle milk.
E.coli	Produces objectionable flavour and ropiness.
Pseudomonas fragi, P. fluoroscens, Achro-mobacter lipolyticum, and *A. lipidus*	They are fat splitting bacteria and produce undesirable colour.
Yeast and mould	Found in milk and milk product which produces acid and gas.

Advantages of clean milk production

Clean milk production is profitable for producers, manufacturer's and consumers as it renders protection against certain milk borne diseases, enables manufacturers to produce good quality dairy products and provides better keeping quality with high commercial value and make safe for human consumption.

The factors responsible for contamination of milk and the desirable farm practices for clean milk production are listed below :

Factors responsible for contamination of milk	Desirable farm practices for clean milk production
A. Internal factors (a) Mastitic udder	1.*Strip cup test 2.** California mastitis test . if positive, discard the milk The cow showing positive mastitis test should be milked separately and during treatment, the milk should be discarded.
(b) Fore milk	Remove first few streams of milk from each teat to reduce bacterial count in remaining milk.
B. External factors (a) Skin and udder of cow	Groom and brush hair coat an hour before milking to avoid dusting in environment. The
(b) Teat of cow	udder must be washed with lukewarm KMnO4 solution and wipe with paper towel individually for each cow prior to milking. The udder should be kept dry at milking. **Pre dipping** - teat should be dipped in antiseptic# solution (i.e., KMnO4) till 30 sec. prior to milking and wiped with paper towel individually to each cow.
(c) Milker	**Post dipping** – immediately after milking dip the teats in cup containing disinfectant (i.e. iodophore etc.). it helps to control mastitis.
(d) Milking equipments or utensils	The attendent engaged in milking should be healthy with clean hands. Nails should be trimmed. He should wear a clean white dress and a cap. He should wash his hands with any antiseptic solution and should not have
(e) Milking shed	bad habits like spitting, coughing, sneezing, talking while milking.
(f) Milking practices	It should be non corrosive preferably of stainless steel, aluminium , dome shaped. It should be cleaned and washed with any detergent or antiseptic solution before use.
(g) Feed and water	It should be well lighted, ventilated ,white washed, clean and disinfected with 1% bleaching powder sol. to arrest cross-contamination & spreading of undesirable odour. Milking should be done quickly, quietly and evenly. Milking should be completed in 6–8 min. each cow. Wet milking should be avoided. Milk should be drained till last strip as it contains more fat and SNF. “Full hand” method of milking should be practiced as knuckling method may injure teats. Feed should be free from mould or dust and objectionable smell at milking time.

*Strip cup test - milk of all four quarters will be stripped into a cup covered with black cloth. If the animal is suffering from mastitis, flakes of milk will be seen on black cloth.

** California mastitis test

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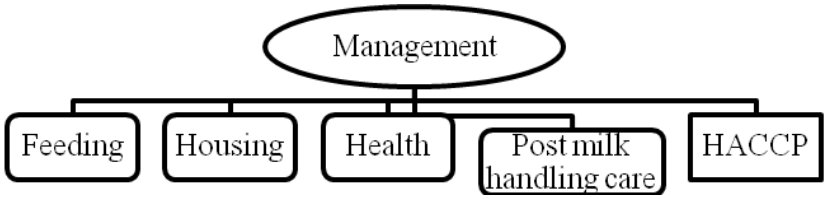
Farm practices for clean milk production can be considered as a part of the managemental strategy. Apart from this other managemental strategies for clean milk production are:



Feeding management

Feeding of milch animal should be done an hour before milking. Balanced feeding with appropriate quantities of green fodder, straw and concentrates having all essential nutrients and minerals is an important aspect required for quality milk production. At the time of milking, for the purpose of keeping cow busy only concentrate should be provided but should not be dusty. Feeds and fodder should be free from pesticides, insecticides, fungicides, herbicides, fumigants, aflatoxins as well as heavy metals. Silage and wet crop residues should not be fed at milking place as it may impart foul odour to the milk. Animal feed and fodder should be free from antinutritional factor and toxins. Feed ingradients should be stored in moisture- free conditions. Rodenticides should be carefully handled. Good quality straw and supply of adequate minerals and vitamins in feeds should be given high priority. Vitamin E and Selenium should be provided in diet, as it prevents mastitis.

Housing management

The cattle shed should be well-roofed, sufficiently, lighted, well-ventilated, dry and comfortable with adequate elevation to avoid stagnation of water. There should be appropriate arrangement for disposal of animal waste in a manure pit .care should be taken to remove left over and fodder lying on ground. Bedding material like sand or sawdust should be provided during cold weather or in damp or marshy floor. Cracks and crevices in animal house should be filled up. Animal should be tied at such a

distance that they cannot lick each other. Each animal should be provided adequate space to move around. Animal house should be cleaned daily.

Traditional shed

Modern shed

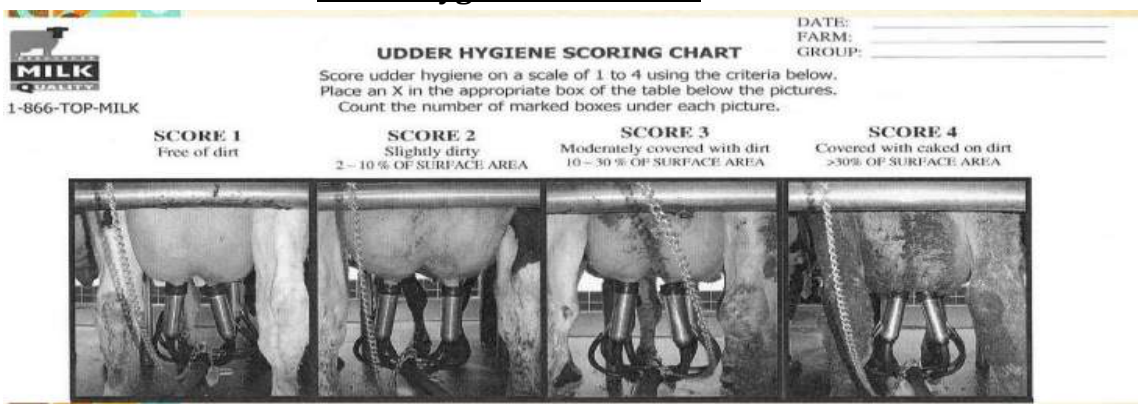
Health management

Routine examination of milch animals against diseases like; tuberculosis and brucellosis should be done regularly by veterinarian. Vaccination of milking animals should be done regularly against FMD, HS and brucellosis. The animals suffering from contagious disease must be kept separate from healthy herd. The inappropriate or prophylactic use of antimicrobial agents must be minimized. Coliform counts on bulk tank milk should be routinely performed as an indicator of faecal contamination. Well defined culling strategies should be followed based on udder confirmation and teat lesions. Udder scoring card ensures the cleanliness of udder of the animal and denotes the prospect of mastitis in animal. Appropriate dry cow therapy should be should be promoted at dairy farm.

Dual objective of dry cow therapy

1. Prevention of new Intra Mammary Infection (IMI) during the dry period
2. Cure of existing of IMI

Udder Hygeine Score Card



Post-milk handling care:

Advantage of producing clean milk is lost if post milking handling is not carefully done. It includes three steps:

1. Filtering	2. Cooling and Storage	3. Marketing
Milk should be filtered with the use of white muslin cloth immediately after milking. Then the filter cloth should be disinfected, washed and dried after use.	Milk should be cooled as soon as possible to a temp. <5°C in a refrigerator and stored at the place which is free from chemicals.	Milk should be delivered to the market as soon as possible. It is advisable to delivery milk early in the morning and evening to avoid hot periods of the day

- Milk pH gives an indication of milk hygiene and it should be between 6.6-6.8, when milk temperature is 20^0 C.

Hazard analysis and critical control points (HACCP):

HACCP system is scientific and systematic approach which identifies a specific hazard throughout the food chain, *i.e.* from primary production of milk till it reaches the consumer. HACCP is management standard, providing a basic framework on which an organization builds up its quality management system leading towards achievement of total quality. The most important reason for adopting HACCP approach is that, no other quality assurance system has gained acceptance throughout the world level, especially in claiming ISO 9000 certification. Now a days HACCP system in dairy unit is very essential.

CONCLUSION

Milk is a food commodity that can have adverse effect if proper management is not done in the farm during its production and handling. Therefore, it is critically important for the dairy farmers to follow various strategies to ensure clean milk production from healthy animals under hygienic conditions. Clean milk production improves economic benefit to the producer and health safety perspective in the consumers. It also improves value of the production through which farmers can get aided benefit.

Care and handling measures of frozen straws for optimum semen quality

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Since the advent of artificial insemination, use of frozen semen for dissemination of superior germplasm increasing day by day for genetic improvement of breeds in terms of production. Success of artificial insemination basically depends on quality of frozen semen and so it is obvious to maintain the quality of semen from production to AI centres, sub centres and till final Artificial insemination. As frozen semen is kept in liquid nitrogen container which are specially designed to maintain the temperature but rough and casual handling may lead to disturbance in internal structure of cryocan and freezing capacity of cryo container may be lost. So special care and attention is required during handling and transport of frozen semen. During removal of straws from container at the time of artificial insemination or during transfer of straws from one container to another due care is needed so that damage to spermatozoa is avoided. General hazard management, personal protective equipments, precautionary measures and emergency management procedures should be followed which are discussed in this document. This article basically intended to aware the people engaged in semen cryopreservation, transport and artificial insemination as well as biological researchers working in semen biology about general handling and care of cryocontainers, removal and transfer of frozen semen straws which should be kept in mind for better results as well as for personal safety point of view.

General precautionary measures during handling of liquid nitrogen:

Liquid nitrogen is a colorless, odorless liquid with a boiling point of −195.79 °C. At low temperatures the gas/vapor is heavier than air. Small amounts of liquid vaporize rapidly to produce large volumes of gas (1 liter of liquid nitrogen will produce 0.7m^3 of gas). Nitrogen gas is invisible and the cloudy vapor which appears when liquid nitrogen is exposed to air is condensed moisture, not the gas itself. Following hazards are associated with the Persons engaged in handling of liquid nitrogen.

- **Asphyxiation:** Liquid nitrogen involves nitrogen gas which is inert and non-toxic but there is a risk of asphyxiation in situations where high concentrations may accumulate and subsequently displace air from the room. Short exposures to cold gas vapor lead to discomfort in breathing with prolonged inhalation can produce serious effects on the lungs and could possibly provoke an asthma attack.

- **Cryogenic burns**: Liquid nitrogen can cause cryogenic burns if the substance itself, or surfaces which are or have been in contact with the substance (e.g. metal transfer hoses), come into contact with the skin.
- **Frostbite**: Continued exposure of unprotected flesh to cold atmosphere can result in frostbite. There is usually sufficient alarming sign by local pain while the frost bite is taking place.
- **Hypothermia**: Low air temperatures arising from the proximity of liquefied gases can cause hypothermia.
- **Adhesion**: The cold surface of equipment and piping containing cryogenic liquid can cause the skin stick to the surface, which will then tear as you attempt to remove it.
- **Boiling and Splashing**: Cryogenic liquids can boil and splash when first added to a warm container
- **Pressure and Explosions**: Large liquid-to-gas ratios can lead to rapid pressure changes as cryogenic liquids vaporize and can lead to an explosion.

Hazards management: To avoid or minimise the hazards, all users of liquid nitrogen should follow the protective guidelines.

Personal Protective Equipment (PPE):

- **Hand gloves**: Non-absorbent insulated gloves extending beyond the wrist must always be worn when handling anything that is or has been in recent contact with liquid nitrogen.
- **Face**: A full face visor and safety glasses must be used to protect the eyes and face where splashing or spraying may occur.
- **Goggles** : Use of chemical splashed goggles is very important when handling liquid nitrogen
- **Body**: A non-absorbent cryogenic apron must be worn where splashing or spraying may occur.
- **Feet**: Close toed shoes are required during handling liquid nitrogen vessels.

Figure-1. Wearing personal protective equipment during handling of Liquid nitrogen container ***Photo source**: Internet

What to do if following condition occurs?

Skin burns:

- Place in a warm place such as the armpit.
- Remove the cloths that may restrict the circulation of the frozen area.
- Flush the area with tap water (Do not use a forceful flow of water as this could cause tissue damage)
- Do not apply direct heat.
- Move the casualty to a warm place (approx 22°C) and seek medical attention, or if the burn is severe call an ambulance

Asphyxia:

- The release of nitrogen into the atmosphere reduces oxygen levels and causes hypoxia.
- Move the casualty to fresh air. If unconscious, open the airway, check breathing and pulse, call for help and be ready to resuscitate

Cryogenic burns/ Frostbite/ Adhesion:

- Use personal protective equipments and always keep in mind that any unprotected part of the body should not come in contact with un-insulated equipment that contains liquid nitrogen.

Hypoxia:

- Install oxygen deficiency monitor in working area.

Pressure and Explosions:

- Use proper equipment that can withstand the pressures.
- Check valves or other protective apparatus on gas withdrawal systems in piping from the container to avoid reverse flow.

Emergency Procedures:

- Evacuate and ventilate the area.
- Open doors and windows or activate forced ventilation to allow any spilt liquid to evaporate and the resultant gas to disperse.
- Try to stop the release if at all possible e.g. turn off valves, but only if it is safe to do so (always wear protective clothing).
- Do not re-enter area unless it is proved safe to do so.

Handling of liquid nitrogen container:

It is very important to understand the internal structure of cryocan and basic principal how it works. Cryocans have walls constructed from two or more layers, with a high vacuum maintained between the layers. This provides very good thermal insulation between the interior and exterior of the cryocan, which reduces the rate at which the contents boil away. Precautions are taken in the design of cryocans to safely manage the gas which is released as the liquid slowly boils. The simplest cryocan allow the gas to escape either through an open top or past a loose-fitting stopper to prevent the risk of explosion. More sophisticated cryocans trap the gas above the liquid, and hold it at high pressure. This increases the boiling point of the liquid, allowing it to be stored for extended periods. Excessive vapour pressure is released automatically

through safety valves. The method of decanting liquid from a cryocan depends upon its design. Simple cryocans may be tilted, to pour liquid from the neck.

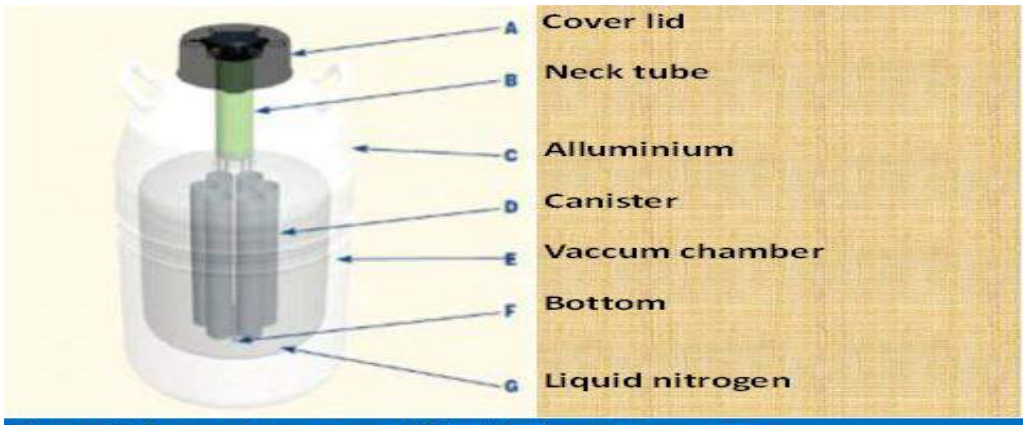

Figure-2. Internal structure of Liquid nitrogen container
*Photo source: Internet

Storage of semen straws in cryocontainer:

1. Always use the cryocan / liquid nitrogen container from reputed company and liquid nitrogen should be added before keeping the straws so that temperature of container reached and stablished at -196 ºc.
2. Always make the proper marking and tagging of straws, goblets and canister so that during removing of straws, checking and lifting of canister again and again should be minimised.
3. During loading and unloading of Container, jerk should be avoided so that cooling capacity of container be maintained for long time.

Transfer of straws from one cryo container to others:

1. First of all keep both the container very close.
2. Check the liquid nitrogen level in container from which straws to be removed
3. Also fill the liquid nitrogen in container in which straws to be kept to a proper level. If using new container then fill Liquid nitrogen before one day so that any leackage should be checked and container temperature should be reached to -196 ºc
4. Room used for transfer of straws should not have direct exposer of light and air. Temperature of room should not be too high.
5. Hold the goblet with precooled forceps and counting of straws should always be done with in frost line of cryocontainer so that temperature shock should be avoided.
6. Keep the canister inside the cryo container as soon as possible.

Removal of straws from cryo container:

1. The level of liquid nitrogen in cryo container should be checked and not be below the half level of the container.
2. Before removing the straws from the container forceps should be precooled by diping in liquid nitrogen.
3. Never lift the canister above the frost line of cryo container.
4. Proper record should be maintained about straws storage, number of goblets and position of canister.
5. Packing of goblet with straws should not be very tight because this not only lead to damage and unavailability of liquid nitrogen to straws but also leads to wastage of time during removal of straws from goblets.

Checking of tag of canister

Lifting of canister below frostline

Thawing of semen straws:

1. Always use thawing unit or water bath or thermal flask maintained at temperature of 37 ºc for straws thawing for 30 to 60 seconds.
2. AI technician should first ensure the right straw number (species and breed specific) for insemination.
3. Use clean, dry and sharp scissor or straw cutter to cut the straw.
4. Always use clean water for thawing of semen straw.
5. Proper attention should be given for time (30 second) and temperature (37ºc) during thawing of straw as it directly affects the conception rate.

Removing of straw from canister | Thawing unit (37°c)

Loading of straw in AI gun:

1. Before removing the straw, first check appropriate tag or bull number.
2. First pre cooled the forceps and lift the canister and keep it inside the frost line of cryocontainer.
3. Always remove one straw at a single time with long precooled forceps.
4. Use thawing unit or water bath or thermos flask depending on the availability and keep the temperature at 37 ºc
5. Don't check the water temperature by dipping finger instead use a good quality thermometer to check the temperature which should be at 37 ºc as too high or too low temperature may lead to damage to spermatozoa and reduces the conception rate.
6. After removing the straw from canister give a light jerk to remove liquid nitrogen from outer surface and air from plug end.
7. Keep straw in water at temperature 37ºc for 30 seconds and always ensure that straw is dipped completely during thawing time.
8. Take out the straw from thawing unit and wipe it completely with tissue paper or clean towel.
9. Cut the straw straight to the lab end with clean, dry and sharp scissor or straw cutter.
10. Load the straw in AI gun and cover the AI with sterile white sheath.
11. Now AI gun is ready for insemination.

12. AI should be done within 2-3 minutes after loading the straw in AI gun to achieve optimum conception rate.

**Note- Photographs taken from internet are just used to disseminate information in more appropriate manner. Authors not claiming these as their personal.*

Arbuscular mycorrhizae : an input for organic agriculture

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Abstract

Green revolution in Indian agriculture has beyond doubts satisfied the hunger of millions of undernourished souls not only in Indian but its positive effect was also found at the global scenario. The crop production was boosted to a greater extent. On the other hand Indian agriculture was gifted with high yielding and fertilizer responsive varieties. The use of high analytical value chemical fertilizers became wide spread which lead to the imbalanced nutrition of the growing plants, pollution of water bodies, air, rain water and soil. Another dark side of the technological intervention is the enormous application of fast acting non target insecticides, herbicides and pesticides. The non judicious use of these harmful agrochemicals have shaken and disturbed the ecological base of the system. Diversity be it microbial, plant or insect, has been devastated to the levels which are irreparable. Population of beneficial insects and microorganisms has been the worst hit. Human beings have also been affected which is reflected from the incidence of lethal ailments. The agrochemicals need to be used in a very sophisticated and judicious manner. There is an urgent need to protect the environment and focus on the green technology, eco-friendly and sustainable inputs in agriculture. Soil has been advocated since the inception as the store houses of almost all the essential plant nutrients, besides it is treated as a living entities as it harbors diverse types of innumerable beneficial microorganisms especially the beneficial genera of bacteria, fungi, actinomycetes, algae etc. Mycorrhizae is one among the wonderful fungi which have multidimensional beneficial effects on the soils and plants under different ecological conditions. This group of fungi is very versatile by means of improving the macro and micro nutrient uptake of plants, enhancing the water relations of crops under stress conditions, protecting the roots from adverse effects of harmful soil microbes. Biomass is also contributed by these fungi besides improving the physical condition of soils. Mycorrhizal fungi can be isolated and mass multiplied crop the crops by very available simple techniques. Organic farming is an ecological production system which largely depends upon the natural sources of nutrients and mycorrhizal fungi along with other beneficial microbes can be used as safe nutrient inputs with greater promise under organic farming practices.

INTRODUCTION

The agriculture sector is facing multidimensional challenges at globally and national level . Continuously increasing the food grain production for feeding the ever increasing population from shrinking fertile land resources and less water without harming the ecosystem is a very challenging task faced by scientists, farmers as well as policy makers. Green Revolution of 1960s gifted the Indian agriculture with fertilizer responsive high yielding varieties, high analysis fertilizers, fast acting pesticides and boosted the production of our nation to greater heights with increased cropping intensity. The use of organic manures as sources of nutrients declined sharply. But miserably in the recent past, the declining trends in productivity is more spectacular in Indian Agriculture. Chemical fertilizers are regularly applied to get maximum yields. But as a result of the chemical reactions these get fixed in the soil resulting only part of it being available over the crop period, necessitating fresh additions. The practice of dependence on inorganic fertilizers is not sustainable because these are produced in ways which can not be continued indefinitely as the resources used in their production are non renewable. Further chemical phosphatic fertilizer production is highly energy intensive process. The excessive use of these fertilizers has deteriorated the soil health and adversely affected its biodiversity. In addition the presence of heavy metals in inorganic fertilizers is well established (Chuck, 2008). Eventually these heavy metals can build up to unacceptable levels especially in the vegetable produce. Average annual intake of uranium by adult is estimated to be 0.5 mg from ingestion of food and water and 0.6 µg from the breathing air.Polonium-210 contained in phosphatic fertilizers is also absorbed by the plants and stored in its tissues. This element has been found to cause about 11,700 lung cancer deaths each year world over Scholten and Timmermans (1992). The conventional agricultural practices have caused soil erosion, reduction in water availability, increased salinization, pollution due to fertilizers, herbicides, reduced socio-economic values, degrading effect on the environment, danger to food security, quality and safety, reduced bio-diversity, lack of sustainable agricultural policies for the future generations etc., such concerns and problems posed by modern day agriculture gave birth to organic farming. Organic farming is a system which avoids or largely excludes use of synthetic inputs (fertilizers, pesticides, growth hormones, feed additives etc.) and to the maximum extent feasibly rely upon crop rotation, crop residues, animal manures, off farm organic wastes, mineral grade rock additives and biological system of nutrient mobilization and plant protection.

Organic farming is a holistic production management system which promotes and enhances agro-ecosystem health including biodiversity, biological cycles and soil biological activity, and this is accomplished by using on farm agronomic, biological and mechanical methods in exclusion of all synthetic off farm inputs.For nutrient management under low input production system many biological inputs are used to support the plant nutrition. Among these mycorrhizae is possessing a unique position by supporting the plant growth and development through its multifaceted role. The

establishment of functional symbiosis is achieved with in 4-6 weeks and thereafter the host plants derive nutritional and biological benefits from VAM symbiosis.

Soil provides an ecological niche for many of the microorganisms including arbuscular mycorrhizal fungi. German botanist Albert Frank in 1885 introduced the Greek word mycorrhiza which literally means "fungus root". These fungi form the beneficial symbiotic association with the roots of higher plants and perform the function of root hair. This symbiotic association has been reported to promote plant growth and health by playing the role of biofertilizer and bioprotectant, respectively. Arbuscular mycorrhizal association is found in 80% of the plant species except *Cruciferae, Chenopodiceae, Caryophyllaceae* and *Cyperaceae* (Hirrel *etal.,*1978*).*The association also occurs over a broad ecological range from aquatic to desert environment. The mycorrhizal symbiosis has been recognized to play a key role in nutrient cycling in the eco system and to protect plants against environmental and biological stresses. In fact, many high value ornamental and edible crops enter in to some form of mycorrhizal association. Most of the crop plants are mycotrophic (i,e. they have the ability to respond to AMF symbiosis),hence functionally, AMF may benefit the productivity and /or vigour of many crops. In addition the mycorrhizal plants have greater tolerance to toxic heavy metals, root pathogens, drought, high soil temperatures, soil salinity, and adverse soil pH and to transplantation shock. Because of their wide spread occurrence in nature and their numerous benefits to plants the fungi are currently attracting much attention in agricultural, horticultural, forestry research. Though there are different mycorrhizal associations, the most common type occurring in all ecological situations, is the vesicular arbuscular mycorrhiza (Bagyaraj, 1989,Barea and Jeffries,1995).Increased plant growth because of VAM colonization is well documented (Bagyaraj and Verma,1995).The increased plant growth is attributed to enhanced uptake of diffusion limited nutrients, harmone production, biological nitrogen fixation, drought resistance and suppression of root pathogens. Biological control can be defined as the directed, accurate management common components of ecosystems to protect plants against pathogens. Several workers have reported that VAM fungi can act as biocontrol agents for alleviating the severity of disease caused by root pathogenic fungi, bacteria and nematodes.

It is evident that an increased capacity for nutrient acquisition resulting from mycorrhizal association could help the resulting stronger plants to resist stress. However,VAM symbiosis may also improve plant health through a more specific increase in protection(improved resistance and or tolerance against biotic and abiotic stresses).Mycorrhizae appear to be extremely advantageous to crops growth in low fertility soils which are characteristic of poorly managed ,continuously cropped agricultural lands as well as drastically disturbed landscape and mined reclamation sites. Increases in mineral uptake as the result of mycorhizal associations are often reflected in increased plant survival, growth and yield as well as nutrition .The improved plant growth is attributed to increased nutrient uptake, especially phosphate, due to the exploration by the external hyphae of the soil beyond the root hair zone. The phosphate uptake is more significant in soils deficient in phosphorus. The increased

growth of plants inoculated with VAM fungi is not only attributed to improved phosphate uptake but also to better availability of other elements like Zn, Cu, K, S, Al, Mn, Mg, Fe etc. Allen *et al.,*(1982) illustrated that VAM affects directly the levels of plant hormones like cytokinins and gibberellins substances. Plants colonized by VAM fungi can tolerate a wide range of soil water regimes ad also improve water relations of many plants.

IMPROVED PLANT NUTRITION

i. Phosphorus: Phosphorus is one of the most important nutrients for plant growth. phosphorus is one of the least available and mobile plant nutrients in the soil (Takahashi and Anwar 2007). Many soils have high reserves of total phosphorus however only 0.1 percent of it is available to plants (Zou *et al.,*1992). At present 5, 49.3, 48.8 and 1.9 per cent of Indian soils fall under adequate, low, medium and high categories of available phosphorus status respectively. The soils of kashmir fall under low category of available phosphorus (Pattanayak and Tarafdar, 2009). Inorganic fraction is an important form of phosphorus in soils .It is generally categorized into insoluble and readily soluble categories. The insoluble fraction is neither available to growing plants nor to microorganisms and constitutes 94 to 99 percent of the total soil phosphorus. This fraction is mostly attached to Fe and Al in acid soils and to calcium in slightly acidic to alkaline soils. Inorganic phosphates when applied to soil get transformed to various reaction products mainly remaining in sparingly soluble orthophosphates of Al, Fe and Ca. Therefore costly phosphatic fertilizers have to be applied to the agricultural fields to maximize production. However the soluble phosphorus in these fertilizers is easily and rapidly precipitated to insoluble forms with cation such as Ca^{2+}, Fe^{3+}, Al^{3+} or Zn^{2+} or adsorbed to calcium carbonate, aluminum oxide, iron oxide and aluminum silicate so the apparent recovery of applied phosphorus in soils is very less i.e. 15 to 20 percent. This transformation decreases the efficiency with which soluble phosphorus can be taken up by the plants and decreases the effectiveness of the fertilizer resulting in the application of increasing amounts of phosphatic fertilizers to the agricultural fields. This unmanaged use of phosphatic fertilizers has increased agricultural costs and instigated a variety of environmental and health hazards as these contain potentially toxic heavy metals (Pb, Cd, As etc).Their excessive use has rendered the fertile soils sick by disturbing the soil microbial biodiversity. Therefore the use of VAM in organic agriculture for enhancing host plant phosphorus nutrition is economically and environmentally promising strategy. There are four general assumptions associated with the improved host plant phosphorus nutrition.

- The external mycelium of mycorrhizal fungus can take up P in the form of trehelose phosphate more effectively than roots at low concentrations.
- The external mycelium can proliferate for beyond the rhizosphere and increases the soil volume which is exploited for phosphorus uptake.The hyphal transport of Phosphorus has been estimated to be 20-90 % and likely to fullfill the entire requirement of fertilizer phosphorus.

- Rapid absorption of soluble form of phosphorus by the external hyphae leads to a shift in equilibrium towards the release of bound phosphorus from soil reserves (Smith and Read,1997).
- Mycorrhizal roots of onion increased the acid phosphatase activity by 20 to 30 times in comparision to non mycorrhizal roots that catalyse the hydrolysis of complex insoluble phosphorus compounds in the soil and increase the soluble form of phosphorus.

These mechanisms aid in the uptake of phosphorus by the host plants and help in reducing the dependence on inorganic phosphatic fertilizers. Thus mycorrhiza plays a pivotal role in the solubilization, mobilization and uptake of phosphorus and can be exploited in organic farming up to the fullest possible extent.

ii. Nitrogen: Nitrogen has the distinction among all the essential nutrients of being called as "Kingpin" nutrient. Its use is indespensible in low as well as conventional production systems. The available nitrogen status in agricultural soils is subjected to varoius losses through the processes like leaching and volatilization. Under such conditions mycorrhizal fungi play a significant role in improving nitrogen nutrition of plants through accusation and assimilation mechanisms.

- The external fungal mycellium plays an important role in direct nitrogen acquisition and transport to the root cells thereby contributing to plant nutrition. Studies by Fray and Schuepp (1993) have revealed that the extraradical mycellium in mycorrhizal fungi can derive ^{15}N from the soil. Subramanian and Charest (1999) in a box compartmental experiment have shown that the amount of nitrate (NO_3^-) ions being transported by the external hyphae was about 30-35% under water deficient conditions.
- Mycorrhizal colonization of roots has increased the activities of nitrogen assimilatory enzymes such as nitrogen reductase (NR), glutamin synthetase (GS),and glutamate synthase (GOGAT) in drought stressed maize roots (Subramanian and Charest ,1998;1999).
- Under soil conditions where less mobile ammonium ions are dominant the role of mycorrhizal symbiotic association becomes more important.
- Mycorrhizal fungi enters in tripartite association (Soybean-*Rhizobium*-*Glomus*) thereby aids in transfer of nitrogen fixed by Rhizobium to the non leguminous neighboring plants.

These evidences suggest that mycorrhizal fungi can successfully be exploited for improvement in nitrogen nutrition of crop plants under organic farming.

iii. Micronutrient nutrition: The external hyphae explores the soil beyond the root hair zone and thereby increasing plant growth by enhancing uptake of diffusion limited nutrients. Mycorrhizal hyphae develop intensively inside the roots and within the soil forming extensive extra radical which help the plant in exploiting mineral nutrients and water from the soil. In plants particularly those with week/restricted root system, hyphal connections act as a bridge between roots and nutrient sites in soil and facilitate efficient uptake of immobile nutrients by host plant. Depending up on the host plant, colonization by mycorrhizal fungi can increase nutrition of micronutrients especially Zn

in addition to Cu, Mn and Fe (Rupam *etal.,* 2008). Among the essential nutrients required by crops, zinc is considered the most critical micronutrient causing yield reduction to the tune of 10 to 50% depending on the severity and stage of occurrence. The magnitude of Zn deficiency is high in almost every type of soil and the major portion of added Zn gets fixed. Further, imbalanced use of fertilizers and non-addition of organic manures are believed to be aggravating the situation. In some cases, zinc deficiency in soil reduces grain yield up to 80% along with reduction in grain Zn content and other nutritional qualities. High dependence on cereal based diets with low levels of Zn brings out malnutrition of human beings and globally, over two billion people are affected by Zn deficiency. Improving food grain production with nutritionally rich grain quality is the need of the hour to sustain grain production and to ensure nutritional security. Despite the fact that importance of Zn nutrition is well known, it is very difficult to ameliorate Zn deficiency in crops due to the extremely low use efficiency of zin (les sthan 1%) by crops and the remaining 99% get fixed in the soil. Indeed, majority of arable lands have high total Zn but the bioavailability is too low, suggesting that there is a need to adopt strategies to transform the unavailable form to available form of Zn. One of the biological means to mitigate Zn deficiency is by exploiting naturally occurring mycorrhizal symbiosis. Arbuscular mycorrhizal (AM) fungi immobile micronutrients such as Zn and Cu.

- Mycorrhizal fungi lower the pH around the rhizosphere that helps in release of Zn from the fixed pool
- The external mycelium of mycorrhizal fungi is very explorative and transport Zn far from the root zone to the tune of 40% contributing for the host plant nutrition.
- Rhizosphere of mycorrhizal roots are biochemically active in term of soil enzymes and release a specific glomalin protein that serves as adsorptive site for Zn which in turn is made available to the host plant.

Interestingly, mycorrhizal fungus are able to extract Zn from tightly bound residual form of Zn and contribute for the organic bound and water soluble forms of Zn**.** As the result of these mechanisms and processes, mycorrhizal plants are more efficient in utilizing the Zn from the soil and help the plants to produce higher grain yield by 10-15%. Thus mycorrhizal inoculation is one of the potential strategies to improve Zn use efficiency by crops besides enhancing the yield and quality of grains.

iv. Plant protection: Mycorrhizal fungi have been well documented as biocontrol agents and the general conclusion is that they can reduce or even suppress damage caused by soil borne pathogen.AMF colonized plants have shown a significant degree of bio protection against various pathogens like *Fusarium,pythopthora,Aphanomyces,Verticillium*(Elsen *etal.,*2001 and Azcon and Barea,1996)) and nematodes causing respectively root rot, lesions, wilt and galls(Guillemin *etal.,*1994).several genes and corresponding protein products involved in plant defense responses have been extensively studied in AMF symbiosis and have been shown to be spatially and temporally expressed (Harrier and watson,2004).These include callose deposition,phytoalexins,β-1-3 glucanases, chitinases and PR

pathogenesis related proteins (Guillon *etal.,*2002).Cordier *etal.,*(1996) showed that pre-inoculation of tomato with an AM fungus subsequently challenged by *Pythopthora parasitica* resulted in less root damage. In that study the authors used immune gold labelling technique to show that the number of hyphae of the pathogen was greatly reduced in mycorrhizal roots and mycorrhizal root tissues infected by the pathogen. The AMF was able to confer bioprotection against *Phytophthora parasitica* via localized and induced systemic resistance in mycorrhizal and non mycorrhizal roots respectively.

v. Alleviation of environmental stresses: Mycorrhization with arbuscular mycorrhizae enable plants to tolerate a wide range of environmental stresses such as drought, toxic metals, saline soil, root pathogens, high soil temperature and adverse *pH*(Caldwell and Virginia,1989).A well developed mycorrhizal symbiosis may enhance the survival of plants in polluted areas by improving water relations, better nutrient acquisition, pathogenic resistance, amelioration of soil structure, phytohormone production and contribution to soil aggregation thus improving the success of all kinds of bioremedation such as decreased caesium uptake by AMF treated plants and can be used effectively in the establishment of plant cover on radio nuclide contaminated soils, thereby reducing environmental risks. Mycorrhization can also be used for attenuation of deleterious soil conditions. They also have the potential to monitor site toxicity or the efficiency of restoration techniques (Weissenhorn *etal.,*1993) . Therefore mycorrhizal fungi enable plants to cope with abiotic stresses by alleviating mineral deficiencies, overcoming the detrimental effects of salinity, improving drought tolerance ,enhancing tolerance to pollution and improving the adaptation of sterile micro propagated plantlets to cope up with sudden stress situations arising as a result of change in environmental conditions encountered as a result of their shift from invitro to in vivo conditions(Barea *et al.,*1993).Mycorrhizae protects the plants from adverse impact of heavy metals by following mechanisms:

A. Biosorption by mycorrhizal fungi:

- Adsorption: Fungal wall (chitin) binds the metals.
- Complexation: Organic acids produced by mycorrhizae forms complex with heavy metals.
- Precipitation: Formation of intra cellular heavy metal phosphates.

B.Detoxification mechanism:

- Avoidance: Some times mycorrhizal mycellium avoids the absorption of metal ions.
- Solubilization: Dilution of metals.

Arbuscular Mycorrhizal Inoculation:

Optimum spore count	:	60-100 spores/100 g soil

Rate of Inoculation:

Vegetables	:	100g/m^2 nursery
Fruit trees and apple	:	100-200g/tree
Other crops	:	10% of seed rate

METHODS OF INOCULUM PRODUCTION:

The thresh hold point related to the use of AM fungi as plant growth promoters is the development of suitable techniques for the production of large quantities of pure pathogen free inoculum with high infectivity potential. Some of the commonly used methods for mass production of AM spores are listed below:

a. Soil based inocula

- **Pot culture**: It is the most widely used standard and conventional method of maintaining AM fungal cultures around the world .In this method AMF spores are inoculated to the roots of a trap plant raised on sterilized soil. Though the usual substrate used in pot culture is sterilized sand-soil mixture, sometimes inorganic inert material like peat, perlite and vermiculite can be also used as substrate (Abdul Khaliq *et al.,*2001).The trap plants commonly used for pot culture are *Sorghum halepense, Paspalum notatum, Panicum maxicum, Cenchrus ciliaris, Zea mays, Trifolium subterraneum* and *Allium cepa* (Chellapan *et al.,*2001).The inoculum so produced ,consists of a mixture of soil, spores, hyphal segments and infected root pieces and generally takes around 3-4 months.
- **Inoculum rich soil pellets:**

A technique of AMF inoculum production, in which soil pellets are enriched with the AMF inoculum was introduced by Hall and Kelson (1981).The pellets had an average dry weight of 1.55 g and measured 12mm × 12 mm × 6 mm. These dry pellets can be glued with seeds by gum arabic and can easily be broadcasted like other fertilizers and spread during seed sowing or transplantation.

b. Soil free inocula:

- **Aeroponic culture:**

Apart from soil based pot cultures being the most widely used method for AMF inoculum production. Now a days ,for physiological, genetic studies for *invitro* mycorrization, the focus is shifting towards alternative soil less cultures for mass production of clean and pure AMF propagules (Mohammad *et al.,*2000).In aeroponic cultures, pure and viable spores of a selected fungus are used to inoculate the cultured plants, which are later transferred in to a controlled aeroponic chamber (Singh and Tilak,2001).where the nutrient solution is provided in the form of a mist. Lack of physical substrate ensures extensive root growth, colonization and sporulation of the fungus and makes it an ideal system for obtaining sufficient amounts of clean AMF propagules (Abdul Khaliq *et al.,*2001).

- **Root organ culture:** The main obstacle in the study of AMF and AMF symbiosis are the obligate biotrophic and hypogeal nature of the endophyte. Several attempts have been made in the past to overcome these hurdles through the use of *in vitro* root organ culture, because of its potential for research and inoculums production. *Agrobacterium rhizogenes* is a gram negative soil inhabiting bacteria, which produces a condition called "hairy roots" as a result of the modified hormonal balance of the tissues that makes them vigrous and allows it to grow rapidly on artificial media((Abdul Khaliq *et al.,*2001).Once the hairy roots are ready, spores are collected either from field or from pot cultures by wet sieving and decanting method(Gerdemann and Nicolson,1963).Generally two types of fungal inoculum are used for initiating

monoxenic cultures; extraradical spores or mycorrhizal root fragments and isolated vesicles of the fungus.In addition to the spores and root fragments, sporocarps of *Glomus mosseae* have also been used by Budi *et al.,*(1999) to establish *in vitro* cultures.After isolating the fungus from the soil,spores are surface sterilized using a sutable surfactant solution.Generally tween 20 and s solution containing a strong oxidizind agent chloramine T are used for sterilization of AMF spores(Fortin *et al.,*2002).Then the spores ae subsequently rinsed thoroughly in streptomycin-gentamycin antibiotic solution(Becard and Piche,1992).All steps starting from spore isolation to rinsing should be done on ice, to maintain spore dormancy. The rinsed spores should be stored at 4^0C in distilled water or water agar or on 0.1 % $MgSO_4.7H_2O$ solidified with gellan gum,I f not used immediately (Fortin *et al.,*2002).

The final step in raising a successful *in vitro* culture is the selection of the appropriate culture medium for dual cultivation of the partners, the host root and the AMF. The nutrient media shold be carefully selected to allow the growth of the host as well as the fungus during the dual culture establishment. Since the root needs rich nutrient medium for its growth and the AMF require normally a relatively poor nutrient medium (Abdul Khaliq *et al.,*2001).Generally, Murashige and Skoog's (1962) and White's medium are used for establishing the dual culture of the host root and the AMF symbionts.

- **Nutrient Film Technique:**

The NFT is another technique of soil less inoculum production, pioneered by Cooper (1975). In NFT, the plant roots are provided with a shallow layer of rapidly flowing nutrient solution. As a result of it,root mats are formed and the upper layer above the liquid retains a film of moisture around them. The pre inoculated seedlings are planted in to the NFT unit. The inoculum produced by this method is ideal for the production of easily harvestable solid mats of roots with more concentrated and less bulky form of inoculum than that produced by plants grown in soil based or other solid media(Abdul Khaliq *et al.,*2001).

- **Polymer based inoculum:** Encapsulation or entrapment of AMF in polymer materials is frequently used as a powerful means of immobilization. It includes the encasement of AMF spores, vesicles or mycorrhizal roots within a porous structure formed '*in situ'* around the biological material. In polymer based inoculum preparation, the AMF are generally mixed with a compound which is then gelled to form a porous matrix under conditions sufficiently mild, so as not to effect viability of biological material. Around 1350 combinations of natural, semi synthetic and synthetic polymers exist for entrapment of AMF (Vassilev *et al.,*2005).But the majority of techniques involving '*in situ'*entrapment make use of natural polysaccharide gels including kappa-carrageeman, agar and alginates. Calcium alginate is the most widely used carrier of choice for encapsulation of AMF. In some cases spores of AMF can be introduced directly in synthetic seeds, which can germinate under suitable conditions and can become complete plantlets.

TECHNIQUES TO OBSERVE VAM FUNGI

Most observations of VA mycorrhizae are based on the use of Trypan blue (0.05%) to stain fungi in host roots (Phillips and Hayman, 1970). In this technique the mycorrhizal roots are treated in hot 10% KOH that first removes the host cytoplasm and then the nuclei. After the roots are neutralized in a weak acid wash, they are stained in Trypan blue. The stain penetrates deeply and usually stains the hyphae but does not deeply stain the plant tissue. This technique generally is satisfactory for agronomic crops and many other species.

Kormanik et al. (1980) described an acid fuschin technique in which clearing and staining of many plant root samples for observation can be accomplished. This technique produces more satisfactory results in plants with heavy pigmented roots. Brundrett et al. (1984) developed another technique in which chlorazol black E allowed the detection of the developmental stages of VAM fungi in the host roots with more clarity than other techniques. There are problems with all these techniques. All the techniques are destructive to the sample and involve time-consuming procedures. Different taxa are stained with different intensities in the same roots. Many species of *Gigaspora* and *Scutellospora* stain intensely with Trypan blue, regardless of the host species (Buchholz and Morton, 1988). *Acaulospora trappei* exhibits intermediate staining in Trypan blue (Abbott, 1982). *Glomus dimorphism, G. fecundisporum, G. leptoticum, G. maculosum, G. occultum, G. tortuosum, Acaulospora myriocarpa*, and *Entrophospora schenckii* are not stained or are weakly stained in Trypan blue (Morton, 1985). The variation in staining may leave regions unstained and cause inaccurate estimations of fungal colonization of a root. Ames et al. (1982) developed a nondestructive approach to estimate fungal metabolic activities in structures within and outside the host roots. This technique depends on using fluorescein diacetate (FDA) as a non-polar molecule that is taken up by the fungus. If the proper enzymes are present, FDA is hydrolyzed, and fluorescein accumulates in the cell. Fluorescein, when excited with ultraviolet (UV) light (450-490 nm), becomes fluorescent and emits at 520- 560 nm. The problem with this technique is that much of the hyphae, vesicles, and intraradical spores are not visible. A further problem is that suberized or lignified root tissue may occlude the fungal structures and auto fluorescence.

It can be concluded here that AM fungi can be used quite successfully as a nutrient input under low input agriculture production system.

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An overview of peripartum Downer Cow and its fertility

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There are many different causes for a 'down' cow (including milk fever) as listed below, but 'downer cow syndrome' is the pathology or problems that develop due to being down. Strictly, the downer cow is defined as one that has been down for longer than 24 hours, is not suffering from milk fever, is in sternal recumbency, there is no obvious cause and is usually related to calving. No matter what the initial cause of recumbency was, after as little as six hours down on a hard surface, muscle and nerve damage in the leg on which the cow is laying on will become the main reason why the cow cannot get up, despite diagnosis and treatment of the primary cause by your vet.

Some Common etiologies for The 'Down' Cow

I. TRAUMATIC

Pelvic fractures
Sacroiliac luxation
Gastrocnemius tendon luxation
Dystocia
Ruptured uterus, haemorrhage, exhaustion

II. METABOLIC

Hypocalcaemia
Hypomagnesaemia
Hypophosphataemia
Fat cow syndrome (Fatty Liver)
Rumen acidosis

III. NEUROLOGICAL

Obturator nerve paralysis
– Usually follows dystocia
Sciatic nerve paralysis
– Following dystocia, prolonged recumbency, struggling to rise
Peripheral nerve paralysis
– Peroneal/tibial paralysis due to trauma/recumbency
General
– BSE, Botulism, Tetanus

IV. TOXAEMIA

Acute Ecoli mastitis
• Acute metritis
• Other conditions
-RDA/volvulus, peritonitis, wire etc

During post partum the calved animal undergo a period of physiological repair till it resume the ovarian activity; which is being influenced by many factors; hence

understanding the mechanism involved in post partum period will helps us in achieving the better fertility.

Postpartum period or puerperium

It is defined as the period in which the gravid uterus after the expulsion of foetus and foetal membrane returns to its normal non pregnant state. It consists of

1. Uterine involution / regression of endometrium
2. Restoration of endometrium / regression of endometrium
3. Resumption of ovarian activity
4. Elimination of bacterial contamination

1. Uterine involution / Regression of endometrium

It is defined as reduction in the size and weight of the uterus following parturition. Following the expulsion of the fetal membranes in the cow, the uterine contractions and peristalsis continue as strong rhythmical waves that gradually diminish through the fourth day. The uterine muscle cell length is shortened from 750µm to 400µm one day latter. From 4th to 8th day there are only irregular undulations of the horn and muscle cell will reach 200µm length. It is indicated that the involution of uterus is rapid upto 4 days after parturition and then the rate of involution is slow between 4 and 9 days and after that rapid involution will occur between 10 and 14 days, after 14th day involution continues in slower rates. The entire uterine contour may be palpable per rectum on 8th day of parturition in primiparous cows and in pluriparous cows on 10th day In the case of peri and post parturient complications and any metabolic diseases, the rate of uterine involution will be delayed.

2. Restoration of endometrium

The maternal placenta involutes by the necrosis of the caruncular stalk and dissolution of the caruncle. Necrosis occurs, mainly due to vasoconstriction and leucocytic infiltration and dissolution occurs due to fatty infiltration, solution, sloughing and detachment of the entire superficial layer of the caruncle that became part of the uterine lochia. The necrosis of the caruncle and its stalk is completed by 5th day postpartum. This dissolution and sloughing of caruncle are completed by 12th day post–partum, leaving a raw surface with protruding blood vessels where the stalk was attached. The caruncles are returned to nearly their original size by the second or 3rd weak and about 25–30 days postpartum, epithelium covers the caruncle and repair is complete. Thus a 70 gm, caruncle by 48 hrs after birth is reduced in size and weight to 26 gms and is quite small 5 days later.

3. Resumption of ovarian activity / cyclicity

Due to the prolonged block of progesterone, the pituitary is refractory to the GnRH stimuli (not responded), but it eventually recovers with time. The observation of first heat after parturition is not an indication of true onset of cyclicity, because the cyclicity would have started few days earlier. Usually onset of oestrus is observed between 33 to 90 days postpartum. Onset of estrus in buffaloes takes about 4–6 months. Onset of postpartum oestrus may be delayed due to suckling, high yielding, nutritive imbalance etc.

4. Elimination of bacterial contamination

During and after parturition chances for entering of microbes into the uterus will be more. These organisms are eliminated by phagocytosis by leucocytes. Hyperleucocytosis is found only during the first 2 to 3 days post partum. Lymphocytes are extremely numerous in the endometrium of infected uteri and also moderate in most bacteriologically sterile uteri. These infections in cows result in lochia assuming a white, yellow–white or grey mucopurulent character toward the latter part of puerperal period. Accessory mechanisms involved in elimination of organisms are uterine contractions, uterine secretions and sloughing of the caruncles. If the onset of ovarian activity is delayed, the elimination of organisms from the uterus will be delayed.

Factors affecting the uterine involution

1. Age – rapid in primipara
2. Season – summer and spring months–very rapid involution winter and autumn months delayed involution
3. Climate – heat stress inhibits the uterine involution
4. Peripaturient abnormalities will delay the uterine involution
5. Postpartum complications will delay the uterine involution
6. Delayed return to ovarian activity
7. Suckling–delays the ovarian activity but enhances the uterine contraction and involution
8. Exercise – mild exercise will hasten the uterine involution.

Approach to the post Downer Cow

The post downer cow has to be focused on three aspects as below in a systematic manner

- ✓ Health
- ✓ Nutrition
- ✓ Reproduction

Health:

For any fertility based programme or treatment intervention the animal has to dewormed with a broad sectrum anthelminths preferably using fenbendazole or fenbendazole with ivermectin

Nutrition:

Around calving, the dairy cow undergoes a dramatic transition from dry and heavily pregnant to fully lactating. This is a stressful period for the cow and she is vulnerable to many problems and disorders that can affect her health and productivity.

Feeding during the last 2-3 weeks before calving not only determines what happens to body condition at this time, but also provides an opportunity to prepare the cow for the coming lactation.

So called 'transition feeding' pre-calving aims to achieve four things for the cow:

1. Meet her nutritional requirements, not just for maintenance, but also for final development of her foetal calf, and development of her udder.

2. Give her rumen microbes time to gradually adapt to the milker diet they will need to handle once she calves.
3. Reduce the chances of her suffering metabolic disorders and other health problems around calving, such as milk fever, grass tetany, ketosis, twisted stomach (displaced abomasum or DA) and retained foetal membranes (RFMs).
4. Enable her to eat more in the first few critical weeks of her lactation, and thereby lose less body condition and produce more milk.

Dietary Cation -- Anion Balance

An additional recent method of avoiding and controlling milk fever is matching dry cow rations for anions (negatively charged molecules) and cations (positively charged molecules). Sodium and potassium are the cations and chloride and sulfur are the anions of interest in formulating anionic diets. The dietary cation-anion balance (DCAB) equation most often used to determine milliequivalents per 100 grams of dry matter is: mEq/100g = mEq (Na + K) - mEq (Cl + S). Based on current research, the range that achieves the lowest incidence of milk fever is a DCAB of -10 to -15 mEq/100g dry matter (DM) or -100 to -150 mEq/kilogram.

Achieving a DCAB of -10 to -15 mEq/100g requires adjustments in the major mineral levels that are quite different than what is normally programmed for regular close-up dry cow rations (no anionic salts)

Balancing rations for anions affects the cow's acid-base status, raising the amount of calcium available in the blood. Urine acidity is affected by these changes in the cow's acid-base status. Checking urine pH can help producers and veterinarians monitor the effectiveness of an anionic ration.

The most commonly fed salts are ammonium sulfate, calcium sulfate, magnesium sulfate, ammonium chloride, calcium chloride, and magnesium chloride. Pay special attention to the degree of hydration of specific salts in formulating rations as well as their costs and availability.

Before incorporating DCAB into a dry cow program, there are several factors to consider. Some of the anionic salts are very unpalatable which can depress intakes significantly in conventional feeding programs. In particular, ammonium salts may result in more intake and palatability problems, especially when a silage based ration is not being fed. Reduced dry matter intakes as a result of feeding anionic salts can lead to the development of other metabolic disorders.

Table 1: Urine pH predicts calcium status of cows at calving.

Ration DCAB	Pre-fresh cow Urine pH	Pre-fresh cow Acid-base status	Fresh cow Calcium status
Positive (> 0 mEq/100g)	8.0 to 7.0	Alkalosis	Low blood calcium
Negative (< 0 mEq/100g)	6.5 to 5.5	Mild metabolic acidosis	Normal blood calcium
Negative (< 0 mEq/100g)	Below 5.5	Kidney overload, crisis	Normal blood calcium

Much of the success with anionic salts has been in herds feeding a total mixed ration. The use of an anionic diet is appropriate when high calcium forages are fed at relatively high levels during the close- up dry period. Animals should receive the anionic diet at least three to four weeks prior to expected calving.

Forages presumed to be good dry cow forages might actually contain high potassium levels that interfere with DCAB. When the potassium level in the total ration dry matter exceeds 150 grams (or > 1.2%), it is difficult to add the proper amounts of anionic salts to meet the ideal DCAB range. Re-evaluating the ration and forages may be necessary if more than 0.65 to 0.75 pounds of anionic salts are needed.

If DCAB is to be implemented in a herd, sodium, potassium, chloride, and sulfur must be included in the forage analyses. Buffers must not be used in anionic salt rations because they will counter the effect of DCAB.

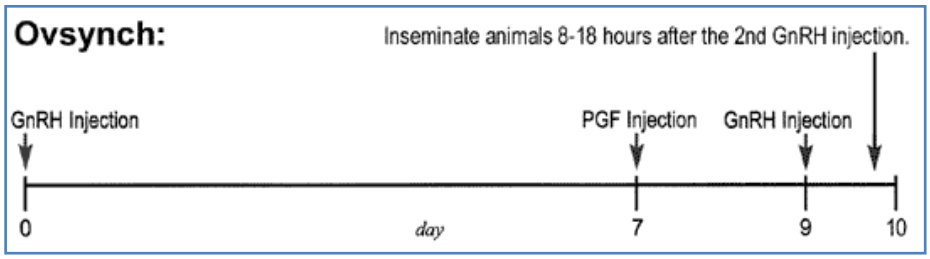
Hormonal intervention in Reproduction

GNRH-PGF$_{2\alpha}$ Based Breeding Programs:

In GnRH-PGF$_{2\alpha}$ based breeding programs, an injection of GnRH causes an LH surge that ovulates or luteinizes most large follicles present in the ovaries. All cows then start a new follicular wave one to two days later. When GnRH is followed by a PGF$_{2\alpha}$ injection seven days later, most cows will possess mature dominant follicles of similar size at CL regression, resulting in a more synchronous heat response. Additionally, the GnRH induced luteinization of dominant follicles will stimulate cyclicity in many anestrous cows. There are several variations of GnRH-PGF based breeding programs commonly used in dairy herds.

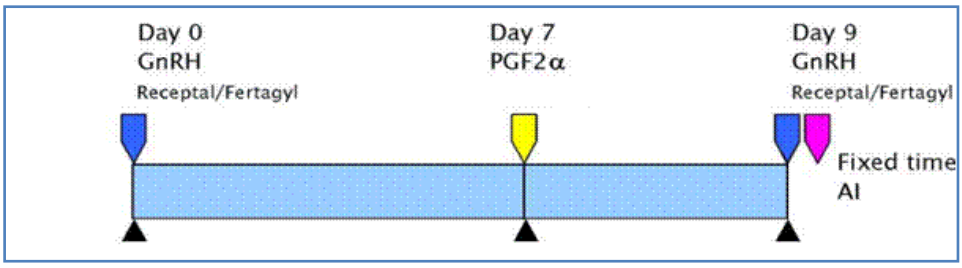
Ovsynch:

Ovsynch protocol builds on the basic GnRH-PGF$_{2\alpha}$ format by adding a second GnRH injection 48 hours after the PGF$_{2\alpha}$ injection. This second GnRH injection induces ovulation of the dominant follicle recruited after the first GnRH injection. Animals are inseminated at 8 to 18 hours after the second GnRH injection. Ovsynch was the first ovulation synchronization protocol developed that allowed for a timed insemination (TAI) resulting in conception rates similar to that of AI after a detected estrus.



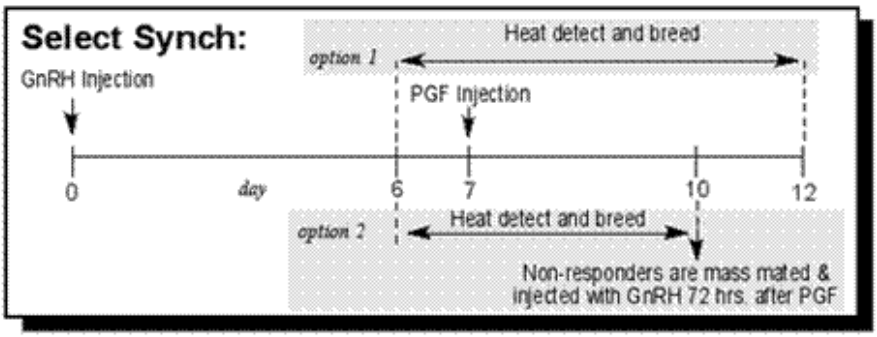
Co-Synch:

Co-Synch is a specific form of Ovsynch in which the TAI occurs at the time of the second GnRH injection. The advantage of Co-Synch is that one less handling is required for each cow compared to Ovsynch.



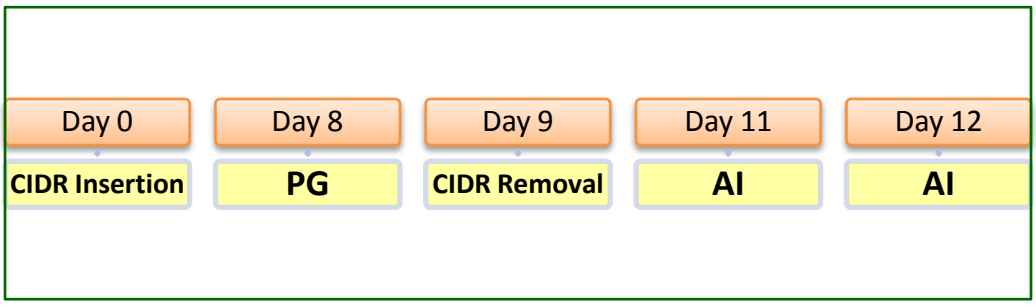
Select Synch:

Select Synch is a breeding option for those herds with good heat detection programs and that prefer to breed cows based to standing estrus. Cows are either bred to detected estrus for three to five days after $PGF_{2\alpha}$ (Option 1) or bred to estrus for 72 hours after $PGF_{2\alpha}$ with non responders time bred at 72 hours with a concurrent injection of GnRH (Option 2). This approach allows most cows (50 to 70 percent) to be bred at standing estrus and gives all cows an opportunity to conceive with the clean-up A.I. at 72 hours. The Select Synch approach saves on hormone costs because only those cows that fail to show estrus receive the second GnRH injection.



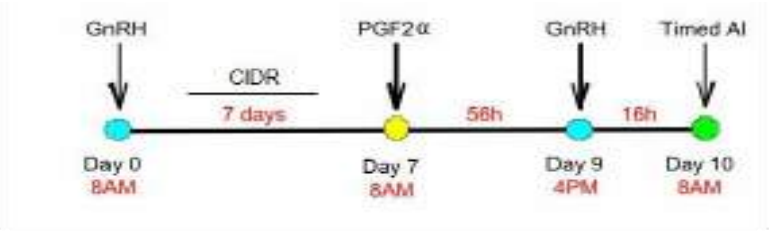
CIDR:

Controlled internal drug release using progesterone plays an important role in priming the hypothalamus after a period of quiescence. Sudden withdrawal of progesterone results in flush of GnRH release and resumption of dominant follicle development and subsequent LH release



OVSYNCH with CIDR:

Insertion of a CIDR device between the first GnRH injection and the $PGF_{2\alpha}$ injection of Ovsynch improves overall synchrony and conception rate in cyclic and anestrus cows.



CONCLUSION

The transition feeding before parturition at least two weeks will helps in prevention of antepartum and postpartum downer syndrome. In addition to that all the dairy cows after parturition needs to be address with sufficient dietary nutrition for the uterine involution and resumption of ovarian activity with the minimum service period of 50-60 days. The first postpartum cyclicity is considered to be the second physiological estrum after calving; even though the postpartum anestrous period gets extended beyond three months of calving hormonal intervention is recommended

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Cow Comfort in Indian Conditions

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A pressing, and often-overlooked matter that poses a significant challenge on most of today's dairy farms is maintaining cow comfort. There are a wide variety of environmental stressors that must be taken into consideration in a dairy operation, and they have a direct impact on the production level of the cows. Some of these stressors include; heat stress, poor ventilation, improper stall/feed-bunk design, and not having adequate access to water. Conditions such as these are not only stressful to the cows, but also greatly affect their physiology and productivity. Design features should ensure that the free-stall provides proper access and comfort. Cows spend greater than one-half of their time lying, therefore their sleeping areas must distribute their body mass uniformly so that their bony protrusions are not subjected to hard surfaces with resulting stressed joints. Floor design should provide good traction for the cows and facilitate effective manure removal. The ventilation system should provide fresh air to each animal space at acceptable air speeds for both cold and warm weather.The role of dairy managers and herdsmen is to ensure that good agricultural, hygienic and animal husbandry practices are employed. The focus should be on preventing a problem rather than solving it after it has occurred.Fortunately, there are practical and economical solutions available to deal with these issues.The objective of this paper is to suggest ways to improve cow comfort during resting, and to provide an environment where the cow can maximize heat loss during hot weather and minimize heat loss during cold weather.

1. Cow Comfort and Housing

Today, because of the demands of an extremely competitive dairy industry and the temperature extremes,dairy cows must be housed during certain times of the year. That being the case, it is imperative that the cow is housed in a comfortable environment to optimize production and reduce stress related problems. To minimize stress the cow should lie down as much as possible. Cows are designed to eat, lie down, eat, lie down, over and over again. If, cows stand simply because it hurts when they lie down, or it is physically difficult to lie down, the pattern will be broken and she will not take that last mouthful of dry matter (DM). If a cow limits her DM intake because of uncomfortable free-stalls the following consequences may occur:

i. Excessive weight loss will occur postpartum, particularly in first calf heifers.

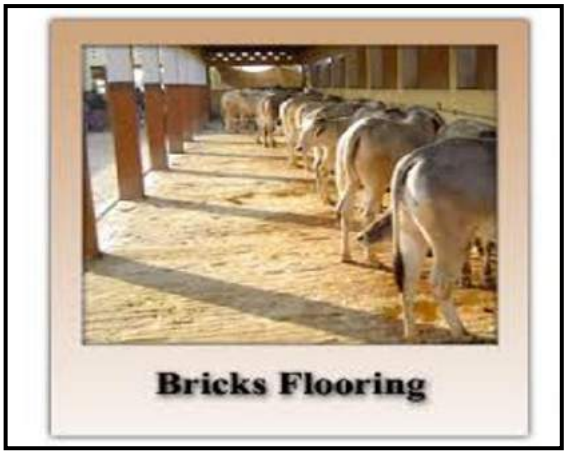
ii. Excessive weight loss will lead to clinical and subclinical ketosis, reduced reproductive efficiency, rough looking hair coat, as well as reduced milk production.

iii. Laminitis in cows can be caused by grain overload, poorly balanced rations, or it can be induced if cows are standing for excessive periods of time on concrete surfaces, and cows under long term stress will have reduced longevity.

These problems are very costly and are frequently blamed on the nutrition program. But in reality they can be due to cows standing for too many hours of the day.

a. **Floor Design:** Skid-resistant walking surfaces reduce injuries, and enhance estrus detection (Bickhart, 1994). Grooved floors are superior to smooth surfaces. Cows have been reported to walk from 180 to 2500 m per day in confined housing, thus they are at a great risk of injury from smooth floors. The manure removal and collection system is related to cow comfort in that frequent removal results in better floor condition. Slotted or scraped alleyways can provide good floor condition for the cows. Infrequent floor cleaning leads to wet surfaces which in turn cause hooves to become softer and more foot related problems to develop. Also, wet concrete can be very abrasive to the hoof. Poor floor design results in animals being reluctant to walk from their resting area to the feed bunk. High stocking density or slippery flooring will discourage animal movement, especially by cows that are low in the social order dominance. Animals must not be forced to compete for restricted amounts of feed or limited bunk space (Fig 1, 2, 3 and 4).

(Fig 1, 2, 3 and 4): Different kinds of flooring



b. **Barn Orientation**: There are many factors that must be taken into consideration when deciding how to orient a barn, which houses cows. The direction is typically characterized by the direction of the ridge running along the roof of the barn. In order to maximize the use of natural ventilation, it is favorable that it be oriented so that the majority of the winds in the warmer months are perpendicular to the barns ridge. We must also take into account the effect of sunlight penetration into the barn. This can cause unused areas of the barn due to the increased heat cause by the sunlight. Barns with a north-south orientation have greater sunlight exposure than one that is oriented east-west. Stall usage in barns located on the east and west outside walls of north-south oriented barns are especially impacted by this solar radiation. Decreasing the effects of sunlight is crucial for heat stress abatement. An east-west oriented barn provides this necessary protection more effectively than one oriented north-south. It is important to note that it is not always practical to orient a barn in this manner, due to the topographical profile of the land. On a farm with rolling hills, the orientation of the barn should be directed in a way to minimize the effects of solar radiation as much as possible.

2. **Cow Comfort and Ventilation**

A well ventilated animal space is important for both the dairy cow and the worker. A proper ventilation system must be designed to avoid high humidity and drafts during the winter, and high temperatures and stagnant air during the summer. An acceptable air quality in terms of respirable dust, ammonia, manure gases, and disease organisms should be maintained throughout the animal space. High levels of respirable contaminants can lead to respiratory problems in cattle and man alike. Ventilation or air exchange can be provided naturally or mechanically. This system allows more daylight into the barn, is noise free, and is less expensive to build than a mechanically ventilated building. Naturally ventilated barns can either be "warm" or have a "modified environment". High relative humidities were observed in the modified environment barns, however, the indoor environment appeared to be excellent when the temperature was in the range of 0 to 5^{o}C (Olofosson,1994).

During the winter, air exchange is provided as a result of warm air rising through the ridge vents and entering through side wall openings. During the summer, the wind force

exchanges the air by means of side panel openings on the windward and leeward side of the building.

Chimneys are now recommended rather than continuous ridge vents. They are cheaper to build, make the building more bird proof, and protect the metal truss connections from the ammonia and water vapor produced in the animal airspace. Vertical moving insulated panels are superior to rotating inlet panels for introducing air. Air mixing may be limited in wide buildings as the incoming air has insufficient energy to encourage good mixing of the fresh and the resident air. Variable speed ceiling mounted fans are very effective in mixing the animals' airspace. During the winter, low air speeds should be maintained to minimize serious drafts; whereas during the summer high air speeds will facilitate cooling of the animals.

a. **Exhaust fans and planned air inlets**: These are used to provide air exchange in mechanically ventilated systems. Winter ventilation must be adequate to maintain acceptable air quality and reduce relative humidity. If ventilation rates are adjusted to maintain temperature during cold weather conditions, humidity and respirable dust level may rise to unacceptable levels. This will lead to building deterioration and exposure of cows to high levels of aerial contaminants. A minimum of 10 and 15 L/s/cow must be maintained at all times for a warm barn and a cold barn, respectively. Exhaust fans are normally evenly spaced on the leeward side of the building.
b. **Air inlet**: Air inlet design is very important in maintaining a good distribution of fresh air into the animal airspace. During cold weather conditions, many dairy barns still use open doors, holes in walls, and manure access ports as fresh air inlets. Poor air inlet design means that inlet openings are too small in some areas, or too large in other areas. This results in areas being stagnant as a result of introducing an inadequate amount of fresh air and results in areas being drafty due to excessive air being introduced.Forced air recirculation is recommended for mechanically ventilated barns since the fresh air entering through the planned inlets usually does not have sufficient velocity to encourage good air mixing. A properly designed ventilation and heating system will result in acceptable air quality and temperatures. This will reduce the exposure level of aerial contaminants to the cow and provide the cow with an acceptable rate of heat exchange between her body and the environment. Producers should be encouraged to buy complete ventilation systems rather than buying components and trying to design systems on their own (Dumelow, 1993).
c. **Lighting:** Lighting requirements must not be overlooked. Suggested lighting intensity for housing is 10 to 30 foot candles. Light meters to evaluate barn are available from Regional Agricultural Engineer. Sixteen to eighteen hours of light is considered optimal as this photoperiod has been observed to increase feed intake and milk yield by 6 to 16% .
d. **Ridge Vent**: Ridge vents are an opening in the roof of the dairy barn used in order to facilitate natural ventilation. In order to maintain adequate cow comfort, dairy cows should be exposed to a continuous supply of fresh, clean air. Having a

vent in the roof of the barn allows for there to be a constant exchange of air, which helps reduce the amount of heat, dust, gasses, odors, airborne pathogens, as well as moisture from inside. The idea behind this practice is that hot, moist air will rise and exit through the roof of the barn. It has been found that the steeper the slope of the roof, the better the results. A general rule of thumb that has been developed in order to help a dairy farmer make a decision on barn design, is that the slope of the roof needs to be at least 3 inches of rise (height) for every 12 inches of run (length). Ridge vent size should be based on the width of the building, and have at least 3 inches of opening for every 10 feet of barn width.

e. **Sidewalls**: Open sidewalls in a dairy cattle barn facilitate airflow. No obstructions should be placed in front of the sidewalls that would prevent winds that facilitate natural ventilation. A dairy farmer should strive for sidewalls that are 14-16 ft high, and are at least 75% open in order to take full advantage of the benefits. In order to compensate for potential rain entering the barn, an overhang of 3 to 4 feet should be provided. It is important to note that natural ventilation can also be supplemented with mechanical ventilation in order to further reduce the effects of heat stress.

f. **Fans/sprinklers**: Fans and sprinklers should be thought of as a form of supplemental cooling only, and when used in conjunction with appropriate ventilation can significantly increase cow comfort during hotter parts of the year. Fan placement should be strategic, and when incrementally installing them throughout a facility close attention should be paid to which part of the operation receives them first. The holding pen should always be on top of the priority list. In addition to also focus on; close-up dry cows, calving area, fresh cow area, and of course the milking herd.

SUMMARY

Globalization will increase competition in the dairy industry in the future. This will ultimately lead to lower prices for milk and therefore we must continually strive for increased efficiency to remain viable. Cow comfort and ventilation problems exist in many barns which lead to reduced efficiency, increased costs, and problems with cow health. The concepts relative to cow comfort and ventilation outlined in this paper should lead to thinking of ways to improve conditions in the many different types of dairy barns. Dairy cow housing design must take cow comfort into consideration. A well designed barn that is spacious, well lit, enjoys good air quality, and has well designed resting areas is conducive to a stress-free environment where dairy cows can perform well. It also provides a good working environment for farm employees. An animal that has a comfortable resting area will be relieved of stress accumulating in their legs and feet. Attention to detail is one of the keys to success in dairying. It is far easier to accomplish this goal in a pleasant working environment than an environment that is stressful to animals as well as barn workers.

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Integrated rabbit farming

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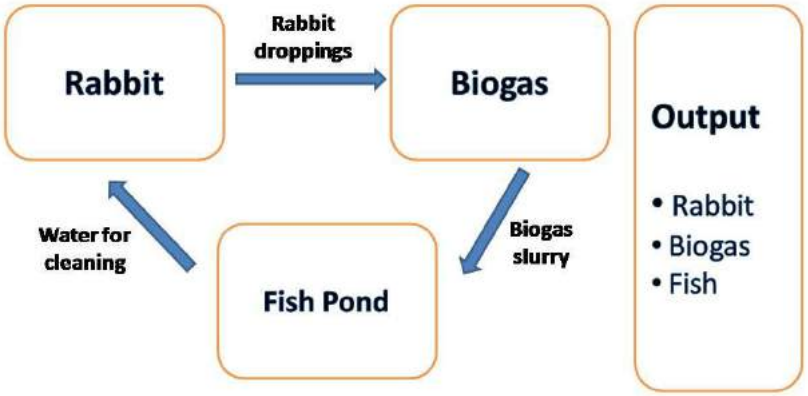
Rabbit (*Oryctolagus cuniculus*), the "micro-livestock" has great potential in providing protein to the vast low-income population in developing countries (Chakrabarti *et al.* 1999). Because of a shorter generation interval (Lebas *et al.* 1986) and high prolificacy, (breeding 5-7 times a year), rabbit farming gives quick returns with low investment, needs little space and results in a high market price compared to other livestock. Many people in Bangladesh prefer rabbit meat as a conventional food item, if available (Reza 1999). Rabbit meat is highly nutritious, easily digestible and an excellent quality food for all people, especially old age and cardiac patients. The meat has comparatively less fat (8 percent), high protein (25 percent) and low cholesterol (50 mg/kg wt), suggesting that it is more suitable for patients (Alabama and Ardeng 1989). The promotion of integrated farming systems is recognized as a developmental strategy that may help alleviate the impending food crisis (Edwards 1986) and improvements of people's livelihoods.Different types of rabbit integration for better livelihood improvement are discussed below.

1. **Rabbit – Biogas – Fish Integration**



No. of rabbit : 600
Biogas capacity : 6 m^3
Fish pond size : 10 × I 0 × 1 m cement ponds with water up

to a depth of 80 cm.

Fish type : Indian carp (Rohu, *Labeo rohita)* and common carp *(Cyprinus carpio)* in mixed culture (1 : 1)

Fish stocking density : 50 each fish /100m ^{2}

Rabbit dropping : 45 kg/600 rabbits /day

Biogas production : 5-5.5 m^3

Fish yield : 8.5 kg/100m^2 in 4 months

Effluent dose : 30 kg /100 m^2

BIOGAS PRODUCTION

An Indian-type 6 m^3 Gobar gas digester can be used.Make a slurry using cow dung (2.5 t, 18% TS) with 2500 liters of water and charge into the digester. Biogas production starts after 15-20 days. Collect 45 kg of rabbit droppings from 600 animals, make a slurry with 150 liters of water and charge to the digester daily after the initial 20 days of incubation In the first 8 weeks, the digester contained a mixture of cow dung and rabbit droppings until cow dung was completely clear of the digester. Following this, the effluent will consist only of rabbit droppings can be collected and used for fish feeding. The average daily rabbit dropping production is 75 g on a wet weight basis per rabbit. It has higher amounts of crude protein, fat, cellulose, starch and total reducing sugars than cow dung. Rabbit droppings slurry at 9% TS produces biogas at 0.24 m^3/kg. In the 6-m ^{3} digester, 5-5.5 m^3 of biogas will be produced continuously after reaching a steady state. The methane content of biogas from rabbit droppings is 68-70% compared to 50-60% from cow dung.

Table 1: Compositions of Rabbit Droppings and Cow Dung (% Dry Matter)

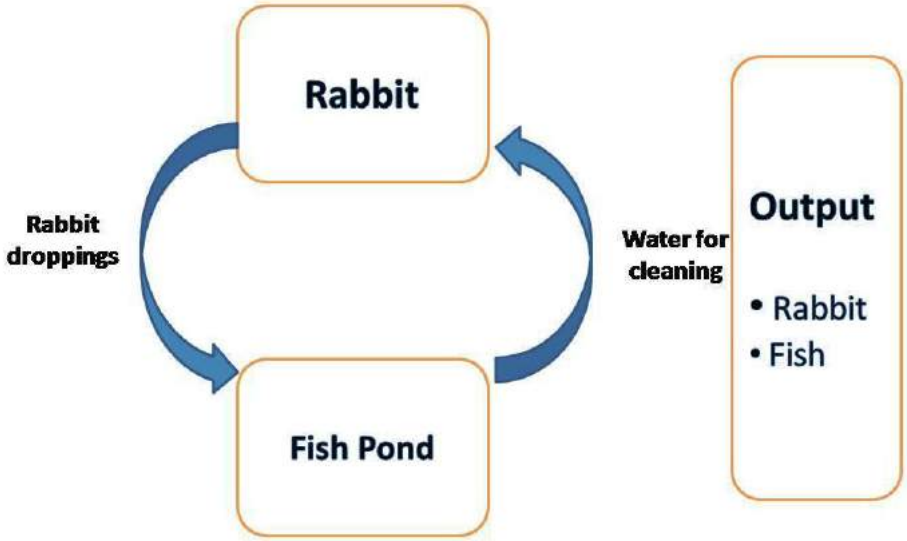
Constituents	Rabbit droppings	Cow dung
Moisture	8.2	8.4
Crude protein	17.1	12.5
Crude fat	0.8	2.5
Cellulose	21.3	17.6
Hemicellulose	10.1	13.2
Starch	7.6	1.9
Total reducing sugar	0.5	Nil
Lignin	15	18
Ash	19	26

AQUACULTURE

Indian carp (Rohu, *Labeo rohita)* and common carp *(Cyprinus carpio)* can be used in a mixed culture (1: 1) in 10 × I 0 × 1 m cement ponds with water up to a depth of 80 cm. Fertilize the pond with biogas effluent at 310 liters (6.5% TS) as an initial dose and diluted with water to a depth of 80 cm. Apply the second dose of 155 liters of effluent after 75 days. The amount of biogas effluent added was based on the reports in the published literature that organic manures at 3000kg/ha on a dry weight basis in two

installments support the optimal growth of fish in polyculture. A week after initial fertilization, stock the pond with uniform-sized fingerlings of Indian major carp (Rohu) and common carp at 50each/100m ^{2} in the pond. Fish yield from the pond is 8.5 kg/ 100m 2 in 4 months, and the extrapolated yield is 3400kg/ha/year.

2. **Rabbit – Fish (Tilapia) Integration (**Mostafa *et.al.* 2009**)**



No. of rabbit	: 1000 rabbits/ha (350 g - 410 g individual weight)
Fish pond size	: 80 m2 with water depth of 1.25 cm.
Fish type	: Tilapia
Fish stocking density	: 30,000 fingerling tilapia /ha
Rabbit dropping	: 2 kg and 3 kg waste /week were produced by three and six month old rabbits
Fish yield	: 3,494 kg/ha in laboratory ponds and 3,270 kg/ ha in on-farm ponds during the 152-day culture period.

Pond preparation

Prepare a pond of 80 m2 area with an average depth of 1.25 m. Treat the ponds initially with lime at the rate of 250 kg/ha followed by organic (cow dung 3,000 kg/ha) and inorganic fertilization (urea and triple superphosphate at 100 kg/ha each).No, follow up fertilizers were needed

Rabbit shed preparation

Prepare rabbit shed using low cost and locally available materials on the pond embankment. Rear the rabbits in bamboo cages. The cage size is 0.42 m3 (1.2 m x 0.7 m x 0.5 m) set on a double tier. The space for one rabbit is 0.14 m2.

Feeding management of rabbits

Soft green grasses and seasonal vegetables can be used as food for the rabbits 24 hours a day. In addition, a mixture of broken rice (50 percent), polished rice (48 percent) and salt (two percent) can be provided at two percent body weight daily. Chick-pea can be provided at one percent of body weight for the lactating does and young bucks.

Quantity and Quality of rabbit dung as manure

A total of 2 kg and 3 kg waste /week will be produced by three and six-month-old rabbits and the waste produced might be sufficient for primary production in the pond. The nitrogen (N), phosphorus (P) and potassium (K) compositions of rabbit dung are compared with goat and cow dung in the table below. These findings indicate that the nutrient compositions and moisture content of rabbit dung are better than those of other livestock.

Table 2: Composition of NPK (%) and Moisture in three (3) different types dung

Manure of animal	% of			% of Moisture
	N	P	K	
Cow	1.7	0.45	0.47	86
Goat	1.6	0.43	0.76	52
Rabbit	2.1	0.52	0.57	72

Pond management

Collect the dung and urine of the rabbits in earthen jars every morning make a slurry with water and add the mixture to the entire pond surfaces every 3 days. No other and inorganic fertilizer is needed.

Feeding management of fish

Locally available rice bran can be applied to the ponds at a rate of 3-5 percent of the tilapia biomass.

Survival rate

The survival rates of tilapia in tilapia-rabbit integration ranges from 66 to 73 percent.

Yield

In rabbit-tilapia culture, the net production of tilapia is 3,494 kg/ha to 3,270 kg/ ha in during the 152-day culture period. The individual harvest weights of tilapia are 150 g to 181g in the tilapia-rabbit integration system.

3. Rabbit – Tree fodder Integration

Feed preferences and feeding systems of rabbits

Rabbits are very selective in their feeding behavior and in the wild will select specific plant parts. They generally select leaves rather than stems, young plant materials rather than old and green rather than dry materials, resulting in a diet that is higher in protein and digestible energy and lower in fiber than the total plant material available. They are much more sensitive to slight changes in the feed than other livestock. Sometimes they will refuse to accept a new diet and will starve rather than accept the new feed for several days (McNitt *et al.*, 2000).

In backyard rabbit rearing systems, the feeding of green herbage is advantageous. Palatable greens are fed *ad-libitum* which can reduce the amount of concentrate pelleted feeds by 50% with no adverse effects on performance of rabbits (Cheeke *et al.*, 1987). Pound *et al.* (1984) reported that the more appropriate approach for smallholder farmers is to grow trees, shrubs and water plants that produce much higher unit area yields of protein in the form of leaf biomass rather than cultivating traditional protein crops, such as soybeans, groundnuts or sunflowers, as components of their farming systems. Strategies to efficiently utilize these unconventional feeds are more likely to succeed when the production system is matched with the available resources (Preston and Leng, 1987). According to Honthong Phimmasan (2005), the palatability of forages is important in rabbit production, particularly in situations when the forages are expected to provide a major part of the daily nutrient intake. Raharjo and Cheeke (1985) reported that tropical legumes were preferred over grasses and agricultural by-products, with the exception of Gliricidia (*Gliricidia sepium*), a legume

which proved to be unpalatable. Leucaena (*Leucaena leucocephala*) is a very palatable to rabbits, even though it contains the toxin, mimosine. Erythrina (*Erythrina lithosperma*), another legume, was well accepted. Tree leaves with potential for feeding include the Mulberry (*Morus spp*.), which has been used in India.

Mulberry (*Morus alba*)

Mulberry has been planted as a substrate for growth of the larvae of the silkworm. It is a perennial tree, capable of being periodically cut in a plantation style, resulting in high biomass yields, which in turn can be improved when the plant is irrigated with effluent from bio-digesters. It is also grown as a shade tree on wastelands and along roadsides, and as a border of fields and around farmers' houses (Sánchez, 2000). Mulberry grows very well in most soils and produces a high biomass yield with proper management. Proper planting density and fertilization and irrigation rates are important strategies to increase yield. It is recommended to cultivate 10,500 to 15,000 seedlings/ha to harvest 26.25 tons/ha/year of leaves. The average annual leaf production can even reach 37.5 to 52.5 tons/ha/year by increasing planting density to 90,000 to 120,000/ha (Yongkang, 2000). In the tropics, Mulberry grows best with a sunlight range of 9 to 13 hours a day (Datta, 2000). Biomass yields were increased when applying fertilizer from livestock wastes in the form of compost or from biodigesters (Rodriguez and Preston, 1996). The yield of Mulberry can reach nearly 35 to 45 tons of fresh leaf/ha/year with CP of 20 to 23% DM and minerals of 12 to 18% in DM. The cell wall constituents have NDF content of 45.6%, cell contents 54.4%, ADF 35.0%, hemicellulose 10 to 40%, cellulose 21.8%, lignin 10%, and silica 2.7% (Lohan, 1980).

Lara y Lara *et al.* (1998) fed rabbits *ad-libitum* mulberry leaves, replacing 85% of a conventional concentrate diet. Although live weight gains were reduced slightly from 22 to 18 g/day, the feed cost was decreased by 50%. The potential of Mulberry leaves for rabbits was confirmed in a preliminary report from Colombia (Preston, 2006; unpublished data) in which rabbits fed only Mulberry leaves had average live weight gains of 20 g/day. Mulberry leaves may be supplemented up to a level of 40% in DM in rabbit diets. Mulberry leaves fed to rabbits as a replacement of concentrates was studied by Bamikole *et al.* (2005) in Nigeria. They concluded that Mulberry leaves when fed up to 50% of the total diet gains to an all-concentrate ration. In overall, satisfactory growth rates were achieved at lower costs.

Moringa

Moringa is a slender, fast-growing, deciduous shrub or small tree reaching 9 to 15 m in height, with an umbrella-shaped, open crown. It is an exceptionally nutritious tree with a variety of medicinal properties, Anwar et al., (2007) and Jiru et al., (2006). Moringa leaves have quality attributes that make them a potential replacement for soya bean in non-ruminant diets of which rabbit is one of them. Sarwatt et al., (2004) reported that Moringa foliages are potential inexpensive protein source for livestock feeding. The advantages of using Moringa for a protein resource are numerous and include the fact that it is a perennial plant that can be harvested several times in one growing season

and also has potential to reduce feed cost. *Moringa oleifera* is in the group of high yielding nutritious browse plants with every part having food value (Duke, 1998). Ufele et al (2013) suggested that; Morinaga oleifera leaf meal could be used to improve the weight gain of domestic rabbits (*Oryctolagus cuniculus*). Moringa oleifera leaf meal is non-toxic to rabbits at the 20% level of inclusion and finally, Moringa leaf meal could be used to replace soya bean meal completely in rabbits' diets as a non- conventional protein source.

Kalyana murungai (*Erythrina indica*)

Erythrina indica is a spreading tropical and subtropical tree legume, renowned as an ornamental for its conspicuous red blossoms. In India, it is one of the most used forage tree legume used as fodder for small ruminants (Devendra, 1989). It is often used as a hedgerow and windbreak. Erythrina variegata foliage is traditionally used to feed rabbits in different tropical countries such as Senegal, Nigeria, Indonesia and Laos (Lebas, 2007; Ryan, 1988). This forage is rich in protein and is well accepted by rabbits. According to different studies it is consumed at levels more or less comparable to those observed with leucaena (*Leucaena leucocephala*) or *Falcataria moluccana* (Raharjo et al., 1985; Raharjo, 1987). Coral tree fresh foliage, when used at 25% to 50% of the rabbit daily ration (DM basis) as a supplement to a concentrate, provided better growth and carcass performance than *Desmanthus virgatus, Leucaena leucocephala and Artocarpus heterophyllus* (Pasupathi et al., 2015; Pasupathi et al., 2016; Pasupathi et al., 2017).

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Soil organic carbon its importance and management

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Carbon (C) is one of the most common elements in the universe and found virtually everywhere on earth: in the air, the oceans, soil, and rock. Carbon is part of geologic history in rock and especially the ancient deposits that formed coal, oil and other energy sources we use today. Carbon is also an essential building block of life and a component of all plants and animals on the planet. It has unique bonding properties that allow it to combine with many other elements. These properties enable the formation of molecules that are useful and necessary to support life. The role of carbon in living systems is so significant that a whole branch of study is devoted to it: organic chemistry. Carbon that is not tied up in rock or deep in the oceans is constantly changing and moving. This process is called the carbon cycle. Soil holds the largest portion of active carbon on earth. Plants take carbon from the air and convert it to plant tissue, some of which returns to the soil as plant residue.

SOC is the main component of soil organic matter (SOM). As an indicator for soil health, SOC is important for its contributions to food production, mitigation and adaptation to climate change, and the achievement of the Sustainable Development Goals (SDGs). A high SOM content provides nutrients to plants and improves water availability, both of which enhance soil fertility and ultimately improve food productivity. Moreover, SOC improves soil structural stability by promoting aggregate formation which, together with porosity, ensure sufficient aeration and water infiltration to support plant growth. With an optimal amount of SOC, the water filtration capacity of soils further supports the supply of clean water. Through accelerated SOC mineralization, soils can be a substantial source of greenhouse gas (GHG) emissions into the atmosphere. Although the overall impact of climate change on SOC stocks is very variable according to the region and soil type, rising temperatures and increased frequency of extreme events are likely to lead to increased SOC losses.

WHAT IS SOIL ORGANIC CARBON

Soil organic carbon (SOC) is one part in the much larger global carbon cycle that involves the cycling of carbon through the soil, vegetation, ocean and the atmosphere (Figure 1). The SOC pool stores an estimated 1 500 PgC in the first meter of soil, which is more carbon than is contained in the atmosphere (roughly 800 PgC) and terrestrial

vegetation (500 PgC) combined (FAO and ITPS, 2015) (See section 3.1 for more information on SOC stocks). This phenomenal SOC reservoir is not static, but is constantly cycling between the different global carbon pools in various molecular forms (Kane, 2015).

In principle, the amount of SOC stored in a given soil is dependent on the equilibrium between the amount of C entering the soil and the amount of C leaving the soil as carbon-based respiration gases resulting from microbial mineralization and, to a lesser extent, leaching from the soil as DOC. Locally, C can also be lost or gained through soil erosion or deposition, leading to the redistribution of soil C at local, landscape and regional scales. Levels of SOC storage are therefore mainly controlled by managing the amount and type of organic residues that enter the soil (i.e. the input of organic C to the soil system) and minimizing the soil C losses (FAO and ITPS, 2015).

SOC: A COMPONENT OF SOIL ORGANIC MATTER

The term SOM is used to describe the organic constituents in soil in various stages of decomposition such as tissues from dead plants and animals, materials less than 2 mm in size, and soil organisms. SOM turnover plays a crucial role in soil ecosystem functioning and global warming . SOM is critical for the stabilization of soil structure, retention and release of plant nutrients and maintenance of water-holding capacity, thus making it a key indicator not only for agricultural productivity, but also environmental resilience. The decomposition of SOM further releases mineral nutrients, thereby making them available for plant growth (Van der Wal and de Boer, 2017), while better plant growth and higher productivity contribute to ensuring food security .

SOM can be divided into different pools based on the time needed for full decomposition and the derived residence time of the products in the soil (turnover time) as follows (Gougoulias et al., 2014):

- Active pools - turnover in months or few years;
- Passive pools - turnover in up to thousands of years.

Long turnover times of organic compounds are not only explained by anaerobic conditions such as in peats, but also by incorporation of SOM components into soil aggregates, attachment of organic matter to protective mineral surfaces, the spatial disconnection between SOM and decomposers and the intrinsic biochemical properties of SOM. Microaggregates are considered responsible for the stabilization of the passive pools (permanent stabilizing agents), whereas macroaggregates and clods encapsulating small aggregates (Degens, 1997) are considered transient stabilizing agents (Tisdall and Oades, 1982; Dexter, 1988). This physical and chemical stabilization of SOM hinders, to different degrees, microbial decomposition via restricted mobility and access of microbes to organic matter, as well as diffusion of water, enzymes and oxygen. In addition, such stabilization requires a broad range of microbial enzymes to degrade the insoluble macromolecules that comprise SOM (Van der Wal and de Boer, 2017). SOM contains roughly 55–60 percent C by mass. In many soils, this C comprises most or all of the C stock – referred to as SOC – except where inorganic forms of soil C occur (FAO and ITPS, 2015). Similar to SOM, SOC is divided into different pools as a

function of its physical and chemical stability (FAO and ITPS, 2015; O'Rourke et al., 2015):

• **Fast pool** (labile or active pool) - After addition of fresh organic carbon to the soil, decomposition results in a large proportion of the initial biomass being lost in 1–2 years.

• **Intermediate pool** - Comprises microbially processed organic carbon that is partially stabilized on mineral surfaces and/or protected within aggregates, with turnover times in the range 10-100 years.

• **Slow pool** (refractory or stable pool) - highly stabilized SOC, enters a period of very slow turnover of 100 to >1 000 years.

SERVICES PROVIDED BY ORGANIC SOIL CARBON

Carbon storage – Increasing the amount of organic carbon in the soil may decrease atmospheric carbon.

Food and habitat for biodiversity – Soils are home to many organisms that, together with plant roots, form the living organic matter, and often use the organic matter as food. They include earthworms, insects (for example, dung beetles, ants and termites, cicadas, locusts, millipedes and centipedes), spiders, mites, snails, nematodes and even some mammals (for example, mice, rabbits, platypus and wombats). In addition, there are many microorganisms – bacteria, fungi, algae and protozoa – that actively contribute to carbon cycling in soils.

Nutrient storage and supply – Soil organic matter can form up to half of the sites for nutrient storage and exchange in some soils.

Erosion control – Soil organic matter stabilises other parts of the soil, binding soil particles into aggregates that are more resistant to erosion.

Buffering capacity – Soil organic matter increases the soil's ability to buffer against changes in pH and may adsorb many pesticides.

Soil moisture – Soil organic matter helps to increase soil aeration, allowing water and air to move more easily through the soil and thus increasing the infiltration rate (so that rainfall takes a shorter time to enter the soil) and water holding capacity of the soil.

How does organic soil carbon change?

At any one time, the organic carbon content of a soil is a balance between the carbon inputs (for example, from roots or crop residues) and carbon losses as a result of decomposition processes. The major inputs are dead plants, animals and microbes, which decay through different processes and at different rates depending on their composition. About half of the losses of carbon dioxide from soils come from respiration by plant roots . The key loss of organic soil carbon is its conversion to carbon dioxide through mineralisation, primarily by microbial activity in the upper layers of the soil. The loss of organic soil carbon in any one year occurs most rapidly in the fast carbon pool, less in the slow carbon pool and is usually negligible in the passive pool. Organic soil carbon is influenced by soil type, position in the landscape, climate, management and soil biota. Organic soil carbon content varies with depth and with soil type. Typically, organic soil carbon content is greater at the surface and diminishes with depth. But in some soils, high concentrations of organic soil carbon can be found at

depths greater than 50 cm. The variability of organic soil carbon across fields can be substantial and can show different patterns at different depths in the profile.

Climate can influence the amount of organic carbon in soil because biological processes such as decay are affected by soil temperature, oxygen levels and soil moisture. As long as soil moisture is sufficient, higher temperatures lead to a faster rate of decomposition and respiration. Soils in humid regions generally have higher organic soil carbon contents because of increased plant growth and biomass production. However, wetter soils lead to faster rates of decomposition provided there is sufficient oxygen.

The amount and quality of organic carbon inputs into the soil are a function of the vegetation present. Increasing plant biomass production would be likely to increase organic soil carbon. Animals such as earthworms, ants and termites may also influence the amount of stable organic soil carbon at lower depths in some soils. There is limited information on how vegetation and organisms affect the organic carbon levels in the stable organic carbon pools at different levels down a soil profile. But decomposition of organic soil carbon is normally slower with increasing depth in a soil.

Management practices such as levels of soil disturbance, rotations, and management history can influence the amount of organic soil carbon. Practices, such as grain cropping with long bare fallow periods, may lose large amounts of organic soil carbon. Some practices such as minimum tillage and stubble retention may lose less organic soil carbon than bare ground, but do not maintain organic soil carbon at levels that could be achieved under pasture.

Nevertheless, minimum tillage and no-till on cropping soils can sequester more carbon than bare ground cultivation.

Practices that reduce soil organic carbon

Some management practices, such as fallowing, cultivation, stubble burning or removal, and overgrazing can reduce SOC by reducing inputs to the soil, increasing the decomposition of soil organic materials, or both.

Cultivation operations can expose SOC and increase losses by decomposition and erosion. Historically, excessive cultivation using inappropriate implements resulted in soils being 'over-worked', and the consequent loss of SOC has caused many land degradation problems such as erosion and soil structural decline.

Fallowing. In the past, keeping the soil bare was a common cropping practice. Fallowing was maintained by repeated cultivation for weed control. SOC declines rapidly under fallowing because of the increased decomposition of organic matter due to the cultivation operations as well as the higher soil moisture conditions prevailing in the fallowed soils.

Management practices that increase soil organic carbon

There are a wide range of management options and farming practices that can increase SOC levels by either increasing inputs or decreasing losses. Inputs can also be increased

by direct additions of organic materials, composts, manure and other recycled organic materials.

Practices leading to increased productivity of crops and pastures – In theory, any management practice that can increase production from an area of land should lead to increased SOC storage because of the increase in carbon inputs. Farmers are familiar with practices such as fertilizer application, improved rotations, improved cultivars and irrigation which can lead to large yield increases. Productivity increases can also be achieved by crop intensification practices such as double cropping, opportunity cropping and multiple cropping. However, it should be noted that some of the yield increasing practices involve the use of fertilizers and irrigation water which require large energy consumption and therefore increase carbon dioxide emission.

Conservation farming – This is rapidly gaining worldwide acceptance as a farming practice to improve soil and water conservation. In cropping, cultivation is either reduced (reduced tillage) or completely eliminated (no-tillage) and stubble (crop residue) is retained. Reduced tillage reduces carbon losses (from both reduced cultivation and reduced fossil fuel usage) and stubble retention increases carbon inputs to the soil; both of these lead to SOC increases.

Use of organic amendments – These are manure, plant debris, composts and biosolids from sewage which are applied to agricultural soils. They are all high in organic carbon and therefore represent additional carbon inputs to the system. Some of these recycled organics also contain a high plant nutrient content and can act as organic fertilizers, reducing the use of inorganic fertilizer. They are important for organic farming systems.

CARBON TRADING

Carbon trading is an admistrative approach used to control pollution by providing incentives for achieving reductions in emissions of pollutants. Also known as emission trading. Overall goal of an emission trading plan is to minimize the cost of meeting a set emission target.

Carbon trading system

Allows the development of a market through which carbon dioxide or carbon equivalents can be traded between participants, whether countries or companies. Each carbon credit is equal to 100 metric tons of carbon dioxide, which can be traded or exchanged in market.

Advantages of carbon trading

- New cash source to companies who are able to maintain their emission levels well within the permissible limits.
- The overall ecological balance is preserved.
- The company or country gets rewarded for applying clean technology in its production process.
- Encourages activities like tree plantings which would help reduce soil salinity, improve water quality and enhance biodiversity.
- By reducing carbon emission, greenhouse gases in the atmosphere will be reduced slowing heat entrapment.

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Information and communication technologies (ICTS) in agriculture

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Agriculture is an enormous sector of the Indian economy and majority of the population is directly or indirectly depends on it. The increased demand for food grains can be met only with sincere efforts in agricultural research and extension. Whereas, agriculture is lagging behind many aspects and characterised by poor connectivity and disintegration of market, unreliable and delayed information, small land holdings, non adoption of improved practices or technologies etc. It has become indispensable to explore various ways to keep our farmers updated about modern technologies and relevant information to pace up them in current technological era. Now a day's information technology revolution is upcoming rapidly and more noticeable. ICTs refers to technologies that provide access to information through telecommunications medium such as the radio, television, cell phone, computers, satellite technology, internet including e-mail, instant messaging, video conferencing and social networking websites which have made it possible for users across the world to communicate with each other to give users quick access to ideas and experiences from a wide range of people, communities and cultures. Hence, ICT in agriculture has become a budding field of research and application related to e-agriculture. Information and communication are always necessary in agriculture to increase the production while to sustain the natural resources.

ICTs IN AGRICULTURAL EXTENSION MANAGEMENT

- **Planning for future resource documentation:** Production of CD ROM on special modern technologies can be the best mean for future resources documentations for farming communities.
- **IT in methods of extension:** E-Extension is a new term coined for electronic extension approach, which is otherwise can be called as I.T. oriented extension approach.
- **For the linkage between research, extension and IT**: The network between different agencies like Krishi Vigyan Kendra (KVK), Farmers Training Centres, Agricultural Technology Management Agency (ATMA) and other information organizations needs to be developed for useful linkage and proper utilization of available resources. The human resources will have to be trained in usage of

information technology tools and all infrastructure facilities required for strengthening the agricultural extension system as well as services.

USE OF ICT IN AGRICULTURE:

- Increasing efficiency, production and productivity by providing timely agricultural information
- Disseminate the crop advisory services and weather related information
- Information about insect-pest and disease control
- Decisions about future crops and commodities and best time and place to sell and buy goods.
- Up-to-date market information of inputs and prices for commodities.
- Helps to build up new business and allow easier contact with friends and relatives.

ADVANTAGE OF ICTS IN AGRICULTURE:

ICTs helps to increase agricultural production, productivity and strengthening the agricultural sector include timely and updated information on agriculture related issues such as new varieties, insect-pest, diseases, weather forecast, pricing control, warning alerts etc.

ICTs CHALLENGES IN DEVELOPING COUNTRIES

Developing countries are now aware of the benefits derived through adoption and use of ICTs but there are many serious challenges which must be addressed and chief among them are: *f*

- Inadequate communications and power infrastructure
- Shortage of ICTs facilities and skills *f*
- Inadequate institutional arrangements *f*
- Limited financial resources *f*
- Inadequate public private partnership *f*
- Limited data management capacity *f*
- Inadequate horizontal and vertical communication
- Inadequate bandwidth nationally and on the Gateway

POLICY THRUST TO STRENGTHEN THE ICTS SECTOR:

- Continuous awareness campaigns, workshops and training program about use of ICTs
- Develop and improve ICTs infrastructure for all sectors of the
- Encourage full utilization of existing communications infrastructure
- Develop supportive and enabling infrastructure to ensure equitable access to ICTs
- Implement measures to develop and retain skilled human resources in the ICTs sector

- Create a complimentary environment for investment through PPPs in the ICTs sector

CONCLUSION

It can be concluded that ICTs can play a key role to disseminate the timely and valuable information among the farming communities which leads to increase the production in the country.

Pongamia: an important botanical for insect pest management

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Botanicals are very important component of integrated pest management as they are safe to non-target organisms, having low mammalian toxicity and are biodegradable. Among various botanicals used for pest management, *Pongamiapinnata*(Linn.)is an important one. It is a leguminous tree and known by different names such as Karanja, Indian Beech, and Pongam*etc*. All plant parts are known to possess bioactivity but seed oil extract was found very effective(Kumar *et al*, 2006). Seed extract containsa variety of secondary metabolites; among them,the most important bioactive chemical is Karanjin, which is a furaflavonoid(Vismaya *et al*, 2010). Because of its various bioactivity of pongamia like direct toxicity, growth inhibitor, antifeedant, repellence *etc*, it is used for the management of various insect pests and plant pathogens.

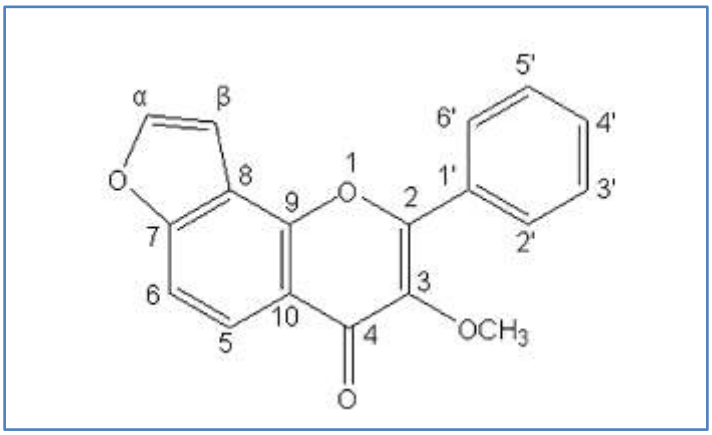

Fig 1: Structure of Karanjin

Bioactivity of pongamia is due to the presence of various secondary metabolites and has shown a range of effects against insect pests.

Direct toxicity

Pongamiaseed extract was evaluated against various sucking and chewing insect pests. It caused significant mortality of *Nilaparvatalugens* under field condition (Hiremath*et al*, 1997).Similarly, it reduced the larval population and plant damage when sprayed against *Plutellaxylostella*, but there was no effect on oviposition (Pavel, 2012).Also, different plant parts extract have varied extent of activity as methanolic extract of seed oil caused maximum mortality of *Spodopteralitura* followed by crude seed oil,

methanolic extract of bark and leaves(Kumar *et al*, 2006). Similarly, seed oil caused highest mortality of *Triboliumcastaneum*, but it was due to leaves extract in case of *T. granarium.*

When evaluated under greenhouse condition, seed oil caused significant mortality of sucking pest like aphid, *Myzuspersicase* and mite, *Tetranychusurticae*, but was found very low effective against *S.littoralis* (Pavel, 2009).

Repellence and antifeedant activity

Apart from causing direct mortality seed oil has also shown host deterrence and ant-oviposition activity. It reduced oviposition by greenhouse whitefly,*Trialeurodesvaporariorum*Westwood on chrysanthemum in greenhouse (Pavel and Herda, 2007)

Pongamia oil was also found to be very effective against storage insect pests as surface treatment of pigeonpea protected the seed damage by preventing egg laying by the *Callosobruchuschinensis*(Singh, 2003)**.**

At low concentrationspongamia shows antifeedant activity against *S. litura*, the activity was maximum with methanolic extract of seed oil followed by crude seed oil, methanolic extract of bark and leaves (Kumar *et al*, 2006). Similarly, *T.castaneum* has shown repellent behaviour when with extracts of leaves.

These studies show scope of pongamia in IPM. But a lot of research is required for designing of extraction method for efficient harvesting of pongamia oil.

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Foreign Body Identification in Food

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Foreign bodies in food constitute one of the most serious causes of consumer complaints and can result in substantial losses and brand damage. While some of these complaints are justified and the objects behind them can be considered as true foreign bodies, others may be due to poorly mixed or misprocessed product. Additionally, it is common for the foreign body to have been introduced into the product by the customers themselves, either accidentally, through home contamination or, more concerningly, as a result of malicious contamination, whether by the complainant or by someone involved in food manufacture or distribution. Nevertheless, when complaints are received, it is important to be able to identify the nature and origin of the object both quickly and cost-effectively, so that an appropriate response can be made. This is particularly so in the age of social networking, where complainants can readily publicize their dissatisfaction.

The food microscopist charged with the laboratory identification of foreign bodies reported from food products will have to use a wide range of techniques in this work. Many of these techniques are classical microscopy and microanalytical methods borrowed from different sciences. A lot of these methods are quite basic and require a minimum of equipment beyond good-quality light microscopes. However, where the number of samples being investigated can justify the investment, there are some more sophisticated techniques that can be employed to great effect.

DNA ANALYSIS

The development of DNA analysis has made an enormous impact, not only on scientific research but also on forensic science, with large numbers of convictions for a wide range of crimes having been based on DNA analysis since the 1980s. This approach also has tremendous potential for work in the identification of foreign bodies, particularly small pieces of animal or plant tissue that cannot be fully identified by either their general appearance or their structure as seen under the microscope. An example of this examined in our laboratory was a small fragment of an animal limb that was reported from a salad leaf product. The general structure indicated that it was a bone joint from a vertebrate animal, but not apparently a mammal. DNA sequencing showed that the sample was from a toad, probably accidentally caught up in harvesting machinery. This investigation was based on DNA bar coding, a taxonomic method that uses a short genetic region in an organism's DNA to identify it as belonging to a

particular species. The reference data came from the international cooperative Consortium for the Barcode of Life (CBOL). CBOL was created in May 2004; since then, more than 200 organizations from more than 50 countries have joined CBOL and agreed to put their bar code data in a public database. The gene region that is being used as the standard bar code for almost all animal groups is a 648-base pair region in the mitochondrial cytochrome c oxidase 1 gene (*Co1*), which is highly effective in identifying birds, insects, fish and many other animal groups. *Co1* is not an effective bar code region in plants because it evolves too slowly, but two gene regions in the chloroplast, matK and rbcL, have been approved as the bar code regions for plants. The CBOL database now includes over 2 million bar code sequences from over 160,000 species of animals, plants and fungi.

However, the potential for DNA analysis is rarely used in routine foreign body identification for a number of reasons. Probably the most important of these is, quite simply, cost—in most foreign body cases, it simply isn't worth spending the money on DNA analysis, which is significantly more expensive than most of the techniques used. Another reason is the practicalities of obtaining suitable comparison samples. For example, to identify the exact source of human hair found in a food product, the analyst would need to have access to reference DNA samples from all likely sources of the hair. This could include a large number of people from the food factory and possibly the complainant as well, and it may well be deemed undesirable to try to obtain all of these samples. A further difficulty is the problem of mixed DNA samples. An example of this might be the identification of a suspect piece of animal tissue in a meat sample. If the suspect tissue has been in intimate contact with the meat from which it was reported—say, lamb—then a normal DNA sequencing approach will inevitably produce a match for lamb. In a case like this, it is necessary to identify all the likely sources of contamination and test specifically for those species using a targeted approach. However, if the correct species type has not been included in the testing, then it will be missed and the conclusion will be that the suspect tissue is lamb.

FOURIER TRANSFORM-INFRARED SPECTROSCOPY (FT-IR)

Infrared spectroscopy has been an important analytical tool for many years, but recent advances have increased its usefulness. The application of Fourier transform techniques to the results has lowered the detection limit from the microgram to the nanogram range and from the ppm to ppb level. Meanwhile, sample presentation has been greatly simplified with the introduction of diamond ATR (attenuated total reflectance) sampling.

Infrared spectroscopy is based on the interaction of specific wavelengths of infrared light with particular chemical bonds in the material being studied, particularly organic molecules. Individual bonds, such as C-O, C-H or C-N, absorb infrared light at a particular wavelength. Illumination of a molecule will produce a spectrum of peaks, and each peak can be related to a particular type of bond. Individual spectra therefore provide a "fingerprint" of individual molecules. This is therefore a very powerful

technique to identify the chemical composition of foreign bodies. It is of most immediate use with common organic materials such as plastics, but is also extremely useful with many other organic materials such as fat, protein or carbohydrate, the identification of tablets or capsules found in food and many other organic samples such as unrecognizable lumps of food material.

FT-IR microscopy can be used to study the chemical composition of very small samples (microsize), in effect using a microscope to apply FT-IR spectroscopy to those samples. However, the most valuable application is in the chemical mapping of a sample of varying composition to determine the chemical identity of particular components. This can be used to study food materials, such as the composition of wheat grains, where chemical mapping shows the distribution of protein, starch and cell walls, which again can help in cases where the foreign body is formed from the food material itself.

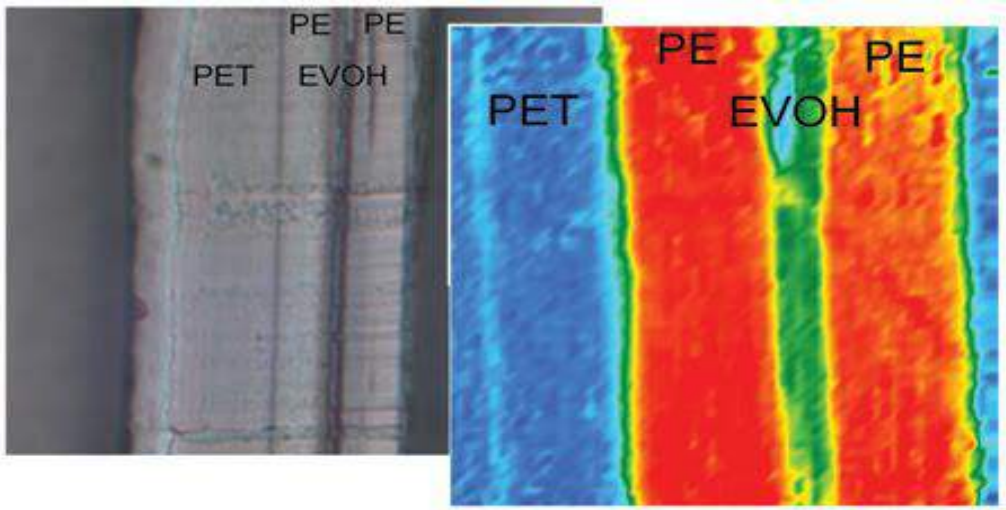

Figure 1: Cross-section of a fragment of packaging film shows it is a multilaminate material (left); FT-IR microscopy (right) identifies the layers as polyethylene terephthalate (PET), polyethylene (PE), ethylene vinyl alcohol (EVOH) and PE, respectively.

FT-IR microscopy can also be used in the analysis of multilaminate plastic packaging materials, which are composed of a number of different, very thin layers, each of which has a specific purpose (Figure 1). When problems are encountered with such materials—for example, if a lidding film will not seal adequately to a food tray, it is important to be able to analyze the different layers to check them against the manufacturer's specification. A cross-section is therefore cut from the film and examined under the microscope, and where fragments of packaging turn up as foreign bodies, the detail of the structure can identify the source of the problem very precisely.

GAS CHROMATOGRAPHY-MASS SPECTROMETRY (GC-MS) AND LIQUID CHROMATOGRAPHY-MS (LC-MS)

GC-MS and LC-MS are powerful analytical techniques for the detection and identification of a wide range of different chemical species, particularly when very small amounts of material are available for analysis. They combine the features of gas or liquid chromatography to separate the chemical components and mass spectrometry to

identify these different substances within a test sample.

One example is the identification of the active ingredient in medical tablets and capsules, particularly useful for medical products with very small amounts of active ingredients. Sample preparation is simply a question of extraction into a suitable solvent that is then injected onto the column of the instrument. The components of the mixture are separated on the chromatography column and the characteristic molecular fragments are identified by mass spectrometry. Commercial spectral libraries are available that include virtually all the various active ingredients used in medical products; the skill is in the interpretation of the data.

Foods and beverages contain numerous aromatic compounds, some naturally present in the raw materials and some formed during processing. GC-MS is extensively used to analyze these compounds, which include esters, fatty acids, alcohols, aldehydes, terpenes, etc. Determining the presence of specific volatile molecules may help in identifying the source of any foreign material in a food sample.

Scanning Electron Microscopy (SEM) and X-Ray Microanalysis
SEM gives pseudo-three-dimensional images with higher magnification and greater depth of focus than a light microscope. Samples can be relatively easily prepared and quickly examined by a scanning electron microscope, making it an invaluable tool for the rapid examination of the three-dimensional structure of many samples.

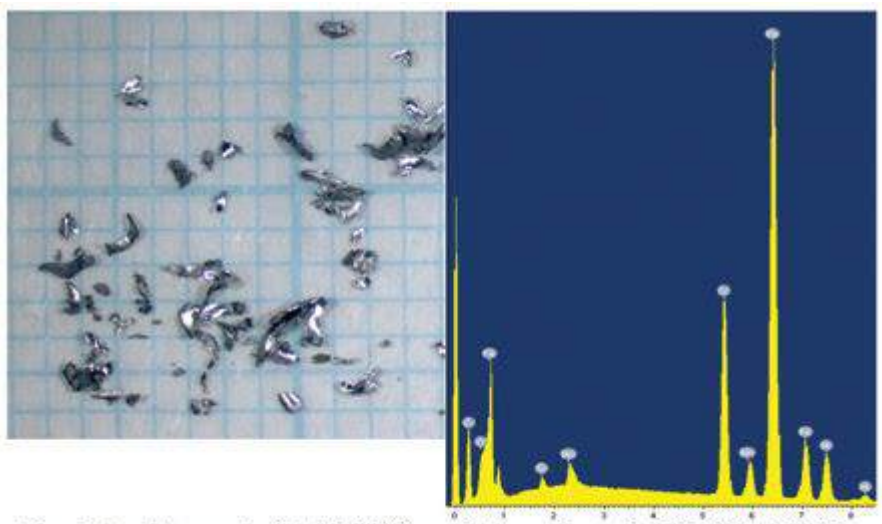

Figure 2: Small Fragments of Metal (left) Shown by X-ray Microanalysis (right) to Be Stainless Steel Type 316

More detailed microanalysis of SEM samples may be carried out using an energy-dispersive X-ray microanalyzer. Whereas FT-IR spectroscopy analyzes the spectra associated with chemical bonds and is therefore primarily useful for organic materials, X-ray microanalysis is used to determine the elemental composition of a material. The energies of the X-rays given off by a sample irradiated with an electron beam are characteristic of the elements present in the sample, and so the X-ray microanalyzer can be used to give a quick nondestructive elemental composition of the sample. Thus, it has

a wide application in foreign body identification. It can be used to determine such things as the mineral composition of a substance, such as the nature of glass found as a foreign object in food. Different types of glass have different levels of elements such as sodium, aluminum, magnesium, lead and calcium—and so can be distinguished by their elemental fingerprint. The technique can also rapidly identify samples erroneously reported as glass, such as struvite (magnesium ammonium phosphate, a harmless glass-like mineral found in canned fish products such as salmon, tuna and crab), salt and silica minerals. Despite the widespread use of metal detectors and magnets in food factories, metal fragments continue to be reported from food products, and the elemental composition of a metal is the key to identifying it as aluminum, tinplate, etc. The various metals used in the construction of food processing machinery can be distinguished using X-ray microanalysis, so that the specific cause of a factory contamination can be pinpointed (Figure 2). The X-ray analyzer can also be used to map the distribution of elements across a sample. An example of this is the examination of discolored areas on mineral fragments, where the finding of iron, chromium and nickel can be used to show that the mineral fragments have passed through stainless steel machinery, probably as part of a food process.

Recent developments in scanning electron microscopes include variable pressure and Environmental. A variable pressure scanning electron microscope avoids the need for coating a sample with gold or carbon to create an electrically conducting surface, required in a conventional scanning electron microscope to avoid a buildup of electrical charge on the sample. A carefully controlled partial vacuum inside the microscope acts as an electrical ground for the sample, although a somewhat poorer image can result. This means that most foreign body, food or packaging samples can be readily examined with virtually no specialized sample preparation. Environmental SEM allows control of not only the vacuum but also the humidity inside the chamber. This allows wet samples to be examined, which is very useful where food samples or moist foreign bodies are concerned, since they can often be analyzed without drying.

COMPUTER-AIDED TOMOGRAPHY (CT-SCANNING)

CT-scanning is a well-known tool in medicine, where it is used for the noninvasive investigation of a wide range of medical conditions, such as cancerous tumors. These instruments have occasionally been used in the study of food products, such as following the development of dough bubbles as bread is proved and then baked. More recently, laboratory instruments have been developed for the noninvasive study of a wide range of objects. For example, they have been used in the examination of archaeological specimens, where it may be desirable to examine an article such as a metal brooch without first removing the surrounding soil and corrosion. The same approach can be useful in the investigation of a foreign body, such as wood, where the internal cell structure is the key to identifying the species of origin. In other cases, it may be necessary to identify a sample without destroying it, if it might be used as legal

evidence or if there is a significant danger of destroying it completely by attempting to cut it open.

CONCLUSIONS

Complaints about foreign bodies in food products are a continuing problem for food companies, and with consumer expectations rising ever higher, they are likely to continue to increase in the future. Pressure upon the food industry to respond in a timely and cost-effective manner is therefore likely to also increase. Hence, the application of more sophisticated methods of foreign body identification will become ever more essential to the laboratory analyzing foreign bodies in food.

Fruits: The Potential Source of Nutraceuticals

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About 2000 years ago, Hippocrates (the father of western medicine) correctly emphasized "Let food be your medicine and medicine be your food". The Indians, Egyptians, Chinese, and Sumerians are just a few civilizations that have provided evidence suggesting that food can be effectively used as medicine to treat and prevent disease this fact was supported by Ayurveda, the five-thousand-year old ancient Indian health science. The change of life style, quality and habit of food styles have increased the possibility of disease. Intake of medicines to combat the disease problems has made life sophisticated. As prevention is better than cure, nutraceuticals can play an important role in controlling them. "Nutraceutical" is a term coined in 1979 by Stephen De Felice. "Nutraceutical" is a combination of two terms "Nutrition" means a nourishing food or food component and "Pharmaceuticals" means a medicinal drug available in many forms and benefits in the health improvements avoiding intake of traditional medicines with side effects. Nutraceutical contain health-promoting ingredients or natural components that have a potential health benefit for the body. Consumer interest in the relationship between diet and health has increased the demand for information on nutraceuticals.

Mother Nature has bestowed mankind with variety of plant species having medicinal properties which aren't fully harnessed till date. Fruit are rich sources of vitamins, minerals, anti-oxidants, anti-inflammatory and antimicrobial phytochemicals. However, Utilization of fruits is in its nascent stage, in the upcoming production of nutraceuticals in a large scale is a reality with the advances in science and technology.

Aegle marmelos L.

Aegle marmelos is an indigenous fruit, commonly known as the Bael. It is a useful medicinal fruit of India known to population since very long time. It is found all over India, from sub-Himalayan forest, Bengal, central and south India. Various parts of this plant such as leaves, fruit and seed possess hypoglycemic, hypolipidemic and blood pressure lowering property. It is also rich in calcium, phosphorus and iron. It is well known for its high content of riboflavin (1.19mg/ 100g edible pulp). Marmelosin is therapeutically active principal present in

Aegle marmelos. The ripe fruits are helpful in various digestive disorders like colitis, chronic dysentery and constipation. Beverage prepared from its fruit is beneficial in healing ulcers due to the presence of mucilage content. Bioactive constituents of its leaves, fruits and seeds have been used in several diseases like diabetes, cardio-vascular and anti-inflammatory. The most important ingredients present are alkaloids, terpenoids, steriods, phenols glycosides and tannins.

Syzygium cumini

Syzygium cumini L. is an indigenous minor fruit of India, commonly known as Jamun (Hindi), java plum, black plum, jambul and Indian blackberry. It is a large, evergreen widely distributed forest tree of India, Sri Lanka, Malaysia and Australia which is also cultivated for its edible fruits. The tree was introduced from India and tropical Asia to southern Africa for its edible and attractive fruits.

Due to its effect on pancreas Syzygium *cumini* L. is universally accepted to be very good for medicinal purpose especially for curing diabetes. The fruit and seed contain glucoside jamboline and ellagic acid which are reported to have the ability to check the conversion of starch into sugar in case of excess production of sugar. Resin, albumen, gallic acid, essential oil and tannic acid are the other nutraceutical constituents of fruit. Besides that, jamun fruit is also an effective food remedy for bleeding piles and liver disorder. It can also prevent diarrhoea, pharyngitis and splenopathy. Processed products like jambolan vinegar can be administered in case of enlarged spleen, chronic diarrhoea and urine retention. Seed is used in various alternative systems of medicine like Ayurveda, Unani and Chinese system of medicine.

Carissa carandas Linn.

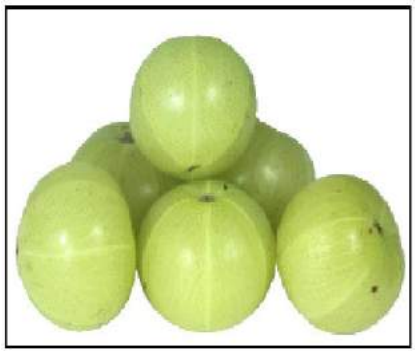
Carissa carandas Linn. is an important, exotic, minor fruit commonly known as Karonda. It is also popular as 'Christ's thorn' which grows wild in bushes. In India, it is cultivated in a limited way in the tropical and subtropical Mediterranean region. Generally used as medicinal plant by tribal throughout India and popular in various indigenous system of medicine like Unani, Ayurveda and Homoeopathy. *Carissa carandas* fruits have been used as a dietary supplement or medicinal food for centuries. A natural 'food colorants cum nutraceuticals supplement' was prepared from its ripe fruits. The formulation had been named as 'Lalima'. 1 ml of this pigment suspension formulation is sufficient to give lovely red color to one serving of any colorless beverage (100 ml) such as lemonade. One serve of such supplemented beverage may in addition contain 469.2 µg anthocyanin, 12.7 mg flavonoids, and 14.1 mg phenol, with total antioxidant activities to be 390 µM Trolox Equivalent. *Carissa carandas* is known to possess

extensive range of phytochemicals in its fruits that impart enormous medicinal value to the plant. These active constituents offer medicinal value to the plant. Pharmacological importance of the plant fruits has been evaluated by several researchers through in vitro and in vivo advances. *Carissa carandas* is found to be a very potent antioxidant. The results suggest that its fruit extract was the most potent antioxidant as it exhibited exceptional reducing power, scavenging activity against Nitric oxide, DPPH and peroxide radicals. Also its fruit is full of calcium, iron, vitamin C, vitamin A, and other nutrients used as food and treatment of many ailments like anorexia, diarrhea, anemia, blood sugar stabilization etc.

Artocarpus heterophyllus

Artocarpus heterophyllus is one of a kind tropical fruit recognized for its unique shape and size, commonly known as Jack fruit. Mainly distributed in tropical and subtropical regions of Asia. *Artocarpus heterophyllus* (Jack fruit) is believed to be originated in the rain forests of India. Today the jack fruit trees are widely grown in Bangladesh, Burma, Indonesia, china, Sri Lanka, Thailand, parts of Africa, Australia, Brazil and Florida. Leaves, fruits, seeds, roots and barks of jackfruit are of great medicinal importance and used in various Ayurvedic and Unani preparations. The ripe fruits are delicious, cooling, laxative, nutritious, and used to prevent excessive formation of bile. Jack fruit is a highly nutritive seasonal food, which is considered as poor man's food in south East Asia. Edible portion of jack fruit is rich in carbohydrate, protein, fat, fiber, calcium, phosphorous, iron, vitamin A and thiamine. Fructose, glucose and sucrose are the major sugars present in jack fruit. The major fatty acids found in various parts of jack fruit are palmitic, oleic, stearic, linoleic, lauric, arachidic acids. The prenylflavones, isolated from Artocarpus heterophyllus was found to serve as powerful antioxidants against lipid peroxidation. In vitro antioxidant evaluation of chloroform extract of Artocarpus heterophyllus fruit pulp by DPPH, ferric reducing power assays and N, N-dimethylp-phenylendiamine (DMPD) radical cation decolorization assays confirmed that the Jackfruit pulp is a good source of antioxidant compounds.

Emblica officinalis



Emblica officinalis has an important position in Ayurveda and Unani systems of medicine, commonly known as Amla. *Emblica officinalis*, a small to medium sized deciduous tree, found in throughout India, Pakistan, Uzbekistan, Sri Lanka, South East Asia, China and Malaysia. Presently *Emblica officinalis* is an underutilized fruit; however, it has enormous potential in the world market. Almost all parts including the fruit, seed, leaves,

root, bark and flowers are used in various Ayurvedic / Unani medicine.

Emblica officinalis is one of the richest sources of ascorbic acid (Vitamin-C) up to 445 mg per 100 g. It contains numerous chemical constituents like tannins, alkaloids and phenols. Its fruit contains two hydrolysable tannins such as Emblicanin A and B are reported to posess antioxidant properties. Due to its strong antioxidant, analgesic, anti-tussive, anti-atherogenic, adaptogenic; cardio, gastro, nephro, neuro protective and anticancer properties, it prevents innumerable health diseases like cancer, atherosclerosis, diabetes, peptic ulcer, anaemia, liver, heart diseases and various other disorders. Therefore, *Emblica officinalis* can be utilized as a possible food additive, in nutraceuticals and biopharmaceutical industries. Several researchers reported that extracts and herbal formulations of *Emblica officinalis* have potential therapeutic benefits against various diseases and their results are very much similar to standard drugs.

Hippophae rhamnoides L.

Hippophae rhamnoides L. is a thorny deciduous shrub commonly known as Seabuckthorn. The distribution ranges from Himalaya regions of India, Nepal, Pakistan, Afghanistan, Britain, Germany, Finland and France. In India, it is found in north western Himalayan states of Himachal Pradesh, Uttarakhand and Jammu & Kashmir (Ladakh). Commonly known as "The wonder plant of Ladakh" and commercially known as "Leh Berry". The entire parts of this plant such as fruits, leaves and seeds are thought to have anti-ageing, memory restoration and energy boosting properties and also considered as rich source of numerous bioactive substances with high medicinal and nutritional properties. The berries of this plant are a rich source of vitamins especially vitamin C and E, carotenoids, polyphenols, vitamins B_1, B_2, K, C, A, E, and folic acid, over 60 antioxidants, at least 20 minerals, and healthy fatty acids and essential amino-acids. It is an absolute power house of nutrients. Owing to its protein building amino acids *Hippophae rhamnoides L*. has multiple uses. In Ladakh, usually 2-3 spoonful of its fruit juice mixed with equal quantity of boiled cold water taken to get better digestion, as aphrodisiac and in lung diseases.

Grewia asiatica

Grewia asiatica is one of the oldest minor fruit of Indian origin, commonly called as Phalsa. It has been stated in Vedic Literature for its medicinal qualities. It is commonly grown around cities or towns in the states like Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, Maharashtra, Bihar, West Bengal, Gujarat, Andhra Pradesh and Jammu and Kashmir.

According to Ayurveda, *Grewia asiatica* fresh fruits have cooling effect, act as a tonic, aphrodisiac, allay thirst and burning sensation, remove biliousness, cure inflammation,

heart and blood disorders and fevers. Triterpenoids, fatty component, flavonoids (quercetin, quercetin-3-O-β-D-glucoside and naringenin-7-O-β-D-glucoside), steroids, saponins and tannins are the major phytochemical compounds present in its fruit. The fruit possess very high antioxidant activity due to presence of vitamin C, phenolic, flavonoids, tannins and anthocyanins. Ripe fruits are good source of vitamin A, C and fair source of phosphorus and iron. All parts of the *Grewia asiatica* are utilized for their nutritional, medicinal properties and other raw and processed products. Fruit of phalsa can be used as an herbal medicine for the treatment of various diseases such as cancer, ageing, fever, rheumatism and diabetes.

Moras alba

Moras alba is a perennial, woody deciduous tree commonly known as Mulberry and locally known as Tut. It has been domesticated over thousands of years ago, adapted to the wide area of tropical, subtropical and mild temperate regions of Asia, Europe, North and South America, Africa and India. In India, it is commonly found in the states like Andhra Pradesh, Assam, Karnataka, West Bengal, Madhya Pradesh and Jammu and Kashmir. *Moras alba* is rich in nutrition. Vitamin and niacin contents present in it are several times to those of apple, which is a natural and nutritious product for health. Its Fresh fruit contains 16 kinds of amino acids, 7 kinds of vitamins, minerals such as zinc, magnesium, calcium and microelements which are deficient in human body. *Moras alba* is one of the traditional herb used in medicine from centuries before. Leaves, fruits, root extract, root bark etc. find use in ayurvedic preparations. Its fruit has various healthcare and medicinal effects such as nourishing liver and benefiting kidney and nourishing blood, alleviating rheumatism and treating dizziness, and promoting saliva generation, and releasing thirst. However, its use is proved in protecting liver, improving eyesight, facilitating discharge of urine, lowering of blood pressure, anti-diabetic and controlling weight in humans. According to Modern medical studies *Moras alba* fruit is used to increase the percentage of macrophage, the phagocytic coefficient, promote transformation of lymphocytes, and improve T-cell mediated immune function.

CONCLUSION

Nutraceuticals, which come under the group of health enhancing foods continues to be gaining tremendous recognition today. Fruits alongside with vegetable, will be categorized as the number of protecting foods and are incredible causes of nutraceuticals and for that reason for enhancing health of a person standard usage of fruits & vegetables can be very important. From the main fruits apart, minor fruits have great potentiality to be used as source of nutraceuticals also. Because the market of nutraceuticals is certainly ever growing, there can be an immediate need to explore the nutraceutical properties.

Importance of post harvest technology of horticultural crops

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Horticultural commodities are highly perishable in nature thus there may be a glut of fruits and vegetables in the market during the peak harvest season. These crops undergo a rapid transformation between the harvest and consumption which results spoilage and reduces market value. The spoilage has been estimated to be nearly 30-40 per cent in most of the produce which account for more than 25,000crores of rupees every year. This is not only a loss to the growers but a net loss of huge human nutrition and wastage of inputs involved. These losses can be minimized to a considerable surplus with timely and safe management of post harvest produce.

Horticulture plays a significant role in Indian Agriculture. India is the second largest producer of both fruits and vegetables in the world accounting 52.85 Mt and 108.20 Mt, respectively (Anonymous, 2016). Fruits and vegetables are of immense significance to man. In India, the fruits have been given a place of honour on being offered to God at every festival and have also been mentioned in our epics like Mahabharata, Ramayana and writings of Sushrutha and Charaka. Being rich source of carbohydrates, minerals, vitamins and dietary fibres these constitute an important part of our daily diet. The dietary fibres have several direct and indirect advantages. Not only this, fruits and vegetables provide a variety in taste, interest and aesthetic appeal. Their significance in human life is being recognised increasingly in Western societies with the objective of minimizing the occurrence of the diseases related with an affluent life style. Their lesser recognized benefits relate to their role in kidney functions, prevention of cancer and cardiac disorders through contribution of ascorbic acid, β-carotene and non-starch polysaccharides besides the biochemical constituents like phenols, flavonoids and alkaloids.

A considerable amount of fruits and vegetables produced in India is lost due to improper post-harvest operations; as a result there is a considerable gap between the gross production and net availability. Furthermore, only a small fraction of fruits and vegetables are utilized for processing (less than 1%) and exported (Fruits – 0.5% and Vegetables – 1.7%) compared to other countries. Post harvest losses in fruits and vegetables are very high (20-40%). About 10-15% fresh fruits and vegetables shrivel and decay, lowering their market value and consumer acceptability. Minimizing these

losses can increase their supply without bringing additional land under cultivation. Improper handling and storage cause physical damage due to tissue breakdown. Mechanical losses include bruising, cracking, cuts, microbial spoilage by fungi and bacteria, whereas physiological losses include changes in respiration, transpiration, pigments, organic acids and flavour.

The advantages of reduction in post harvest losses are as under:

1. Availability of fruits for longer durations.
2. Better returns to the fruit grower
3. Increase production without bring any additional land into fruits.
4. Availability of fruits to the consumers at low price.
5. Better nutrition to the consumers

CAUSES OF POST-HARVEST LOSSES

Losses occur after harvesting is known as post harvest losses. Fruits are perishable in nature as it contains 80-95% moisture, high rate of respiration, more surface area and delicate texture. Lack of harvesting equipments, collection centers in major producing areas, suitable containers, commercial storage plants and lack of cold chain in complete post harvest handling are the possible reasons for providing a suitable media for the rotting and senescence.

The causes of post-harvest losses can be divided into different categories:

1. **Metabolic**
   All fresh horticultural crops are live organs. The natural process of respiration involves the breakdown of food reserves and the aging of these organs.
2. **Mechanical**
   Owing to their tender texture and high moisture content, fresh fruits and vegetables are very susceptible to mechanical injury. Poor handling, unsuitable containers, improper packaging and transportation can easily cause bruising, cutting, breaking, impact wounding and other forms of injury.
3. **Developmental**
   These include sprouting, rooting, seed germination, which lead to deterioration in quality and nutritional value.

Table: Post-harvest losses of major horticultural produces.

Sr. No	Name of Crops	% Average Loss (CIPHET, 2012)	% Average Loss (CIPHET, 2015)
1	Apple	12.3	10.39
2	Banana	6.6	7.76
3	Citrus	6.4	9.69
4	Grapes	8.3	8.63
5	Guava	18.01	15.88
6	Mango	12.7	9.16
7	Papaya	7.36	6.70
8	Sapota	5.8	9.73

9	Onion	7.5	8.20
10	Tomato	13.0	12.44
11	Cabbage	6.9	9.37
12	Cauliflower	6.9	9.56
13	Green peas	10.3	7.45
14	Potato	9.0	7.32
15	Tapioca	9.8	4.58

4. **Parasitic diseases**
   High post-harvest losses are caused by the invasion of fungi, bacteria, insects and other organisms. Micro-organisms attack fresh produce easily and spread quickly, because the produce does not have much of a natural defense mechanism and has plenty of nutrients and moisture to support microbial growth.
5. **Physiological deterioration**
   Fruits and vegetable cells are still alive after harvest and continue their physiological activity. Physiological disorders may occur due to mineral deficiency, low or high temperature injury or undesirable atmospheric conditions, such as high humidity, physiological deterioration can also occur spontaneously by enzymatic action leading to over-ripeness and senescence, a simple aging phenomenon.
6. **Lack of market demand**
   Poor planning pr inaccurate production and market information may lead to over production of certain fruits or vegetables which can't be sold in time. This situation occurs most frequently in areas where transportation and storage facilities are inadequate. Produce may lie rotting in production areas, if farmers are unable to transport it to people who need it in distant locations.
7. **Consumption**
   These losses can be due to inadequate preservation methods at home, methods of cooking and preparation such as peeling, consumption styles etc.

TECHNOLOGIES FOR MINIMIZING THE LOSSES:

Fruits and vegetables are perishable in nature. Scientific harvesting and handling are the practical way to reduce the losses due to physical damage, spoilages, due to insect damages and microbial growth. Various protocols are standardized and available for adoption to get the best result, which will give economic benefits. Similarly, proper storage conditions, with suitable temperature and humidity are needed to lengthen the storage life and maintain quality once the crop has been cooled to the optimum storage tempera Lure. Greater emphasis need to be given on the training of farmers, creation of infrastructure for cold chain with common facilities for sorting, grading, packing and post harvest treatments in all major markets. Some technologies for extension of shelf life of fruits and vegetables are:

The shelf life of the fruits can be extended by various post harvest treatments.

1. Chemical treatments: Chemicals namely growth regulators and fungicides applied as pre- harvest and post harvest are beneficial to enhance the shelf-life of many fruits. e.g. Giberillic Acid, cytokinin and ethreal etc.
2. Waxes and oil emulsions: Application of different waxes and oil emulsions have been found effective in increasing the shelf life of various fruits. e.g. Kinnow, apple etc.
3. Hot water treatment: generally given as the wax layer is removed after washing. It helps in controlling the ripening behaviour and pest control, which leads the way for longer storability. eg. mango.
4. Irradiation: ionizing radiation control the growth of microorganism and alter the physiology of the fruits. The dose and duration is vary from fruit to fruit.
5. Controlled Atmosphere (CA) storage: It is based, on the principle of maintaining an artificial atmosphere in storage room, which has higher concentration of CO_2 and lower concentration of O_2 than normal atmosphere. This reduces the rate of respiration and thus delays aging. This method of storage is very effective when combined with low temperature storage.

Climate change and food security

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Abstract

Climate change will dramatically alter global food production. Agriculture is not only affected by climate change but also contributes to it. Ten to twelve percent of global greenhouse gas emissions are due to human food production (IPCC, 2007). In addition, intensive agriculture has led to deforestation, overgrazing and widespread use of practices that result in soil degradation. These changes in land use contribute considerably to global CO_2 emissions. Food security is the outcome of food production system processes all along the food chain. Climate change will affect different dimensions of food security - including food availability (i.e., production and trade), stability of food supplies, access to food and food utilization. Agricultural output in developing countries is expected to decline by 10-20 percent by 2080. Globally, the potential for food production is projected to grow with increases in local average temperature over a range of 1-3°C, but above this it is projected to decrease. In seasonally dry and tropical regions, even slight warming (1-2ºC) reduces yield. Temperature increases of more than 3°C may cause food prices to increase by up to 40 percent. Increases in atmospheric CO_2 are raising ocean acidity. Existing projections indicate that future population and economic growth will require a doubling of current food production, including an increase from 2 billion to 4 billion tonnes of grains annually. However agricultural production in many countries including India would be severely compromised by climatic variability and climate change. Sustainable agriculture and food supply systems are thus more urgently needed than ever before.

Key words: Climate Change, Green House Gases, Organic Agriculture, Food Security

INTRODUCTION

Climate change will dramatically alter global food production. The inequity in food supply between industrialized and developing countries is expected to increase, as the 40 poorest countries in the tropical and subtropical zones will suffer due to droughts and periodic floods. As the world's population increases and with it the number of affluent people the demand for food and renewable energy crops will also increase. This combined with the increasing severity and frequency of climate change impacts and the rising price of fossil fuel based chemical fertilizers, herbicides and pesticides will put huge pressure on agricultural production and most significantly on the world's poor. These factors will result in huge increases in the number of hungry people around the world.

Climate change and the global food crisis have put a spotlight on the vulnerability, unsustainability and social inequity of agriculture and food production. Policy makers are now referring to 'soil organic matter', to 'soil carbon,' to 'ecosystem services' and to 'holistic' approaches, all of which are long established core pillars of Organic Agriculture. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) the direct agricultural greenhouse gas (GHG) emissions was account for 10 -12%. However, emissions due to the production of agricultural inputs such as nitrogen fertilizers, synthetic pesticides and fossil fuels used for agricultural machinery and irrigation are not calculated. Furthermore, land changes in carbon stocks caused by some agricultural practices are not taken into account, e.g., clearing of primary forests.

Conventional agriculture contributes to climate change:

It uses synthetic fertilizers and pesticides that require significant amounts of energy to manufacture It applies excessive amounts of nitrogen fertilizer that is released as nitrous oxide It operates intensive livestock holdings that overproduce manure and methane It relies on external, soy-based animal feed that requires large amounts of fuel to travel thousands of kilometers to reach the farm. It mines the earth of the nutrients needed to sustain production thereby leading to the clearing of rainforest and "slash and burn" techniques that reduce carbon storage and release huge amounts of carbon dioxide from burning vegetation

The role of agriculture in climate change

Agriculture is a major contributor to emissions of methane (CH4), nitrous oxide (N2O), and carbon dioxide (CO2). On a global scale, agricultural land use in the 1990s has been responsible for approximately 15% of all GHG emissions. One third of all carbon dioxide emissions come from changes in land use (forest clearing, shifting cultivation and intensification of agriculture).Approximately two thirds of methane and most of nitrous oxide emissions originate from agriculture. At the same time, agriculture offers options to reduce GHG significantly. One is to reduce emissions and, thereby, to minimize the production of atmospheric CO2, CH4 and N2O.

For intensive agricultural systems, it uses significantly less fossil fuel in comparison to conventional agriculture. This is mainly due to the following factors, Soil fertility is maintained mainly through farm internal inputs (organic manures, legume production, wide crop rotations etc.), In avoiding methane, Organic Agriculture has an important though not always superior impact on reduction. Through the promotion of aerobic microorganisms and high biological activity in soils, the oxidation of methane can be increased. Secondly, changes in ruminant diet can reduce methane production considerably. However, technology research on methane reduction in paddy fields an important source of methane production – is still in its infancy. Nitrous oxides are mainly due to overdoses and losses on nitrogen has great impact on agricultural production with respect to climate change..

Major sectors of greenhouse gas emissions and main sources in agricultural sector

S.No	Green house gas emission

	Sectors (Barker *et al.,* 2007)	**(%)**	**Agriculture sector** (Smith *et al.,* 2007)	**(%)**
1	Waste water	2.80	Rice production	11.00
2	Energy supply	25.90	Biomass burning	12.00
3	Transport	13.10	Enteric fermentation	32.00
4	Buildings	7.90	Manure	7.00
5	Industry	19.40	Soil emissions	38.00
6	Agriculture	13.50		
7	Forestry	17.40	(Source: IPCC 2007)	

EFFECTS OF CLIMATE CHANGE ON PLANTS

Increased carbon dioxide levels in the atmosphere as a result of climate change will alter global temperatures and rainfall amounts. These factors will influence how well plants grow and affect food production.

Increases in temperature

Higher temperatures cause heat stress in plants. This means they grow less and produce less crops. In some cases, the plants do not reproduce at all since excessive heat causes sterility of the pollen (the masculine reproductive part of the flowers). A temperature increase may be beneficial in areas which are very cold at present. For example, in Siberia or Northern Europe it may, in the future, be possible to grow crops for longer periods of the year.

Reduced rainfall - Drought

Water availability directly affects the growth of plants and how much crop they produce. The pictures above show corn fields in Africa under normal weather conditions and during drought when nothing grows. In most parts of Africa there is not enough water even in normal conditions for high crop yields. In contrast, in the USA, corn is grown with enough water and difference in crop growth between the continents can be clearly seen.

Increased rainfall

Excessive rainfall results in floods. Waterlogged soil causes plant roots to rot and heavy rainfall damages tender young plants. Increased rainfall without flooding may be beneficial in very dry areas and allow limited crop growth. So changes in temperature and precipitation patterns as a result of climate change are likely to be bad for large areas of the world but may increase crop production in other regions. However, one of the likely outcomes of climate change is also an increase in the severity of rain storms and droughts and both of these are likely to have large and devastating effects on agriculture.

Increases in carbon dioxide levels in the air

The increase in atmospheric carbon dioxide (CO_2) levels resulting from fossil fuel combustion has a fertilizing effect on most plants since CO_2 is needed for photosynthesis (the biochemical mechanism of plant growth). Photosynthesis converts carbon dioxide and water into the simple sugar glucose and emits oxygen, making it possible for animals

to live on Earth. Sunlight is the energy that powers this reaction. The basic equation of the process of photosynthesis is:

$$6H_2O + 6CO_2 + light \text{ -----> } C_6H_{12}O_6 + 6O_2$$

The reduced levels of rainfall leads to drought and increased levels of carbon dioxide in the air and increased levels of rainfall also seriously affects climate change in agriculture.

Food security

When all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

Dimension of food security / Pillars of Food Security:

1. Availability, 2.Access and 3.Distribution

CLIMATE CHANGE AND FOOD SECURITY:

1. Impacts on Food Production and Availability

Climate change affects agriculture and food production in complex ways. It affects food production directly through changes in agro-ecological conditions and indirectly by affecting growth and distribution of incomes, and thus demand for agricultural produce. Impacts have been quantified in numerous studies and under various sets of assumptions. A selection of these results is presented in *Quantifying the Impacts on Food Security*. Here it is useful to summarize the main alterations in the agro-ecological environment that are associated with climate change. Changes in temperature and precipitation associated with continued emissions of greenhouse gases will bring changes in land suitability and crop yields.

2. Impacts on the Stability of Food Supplies

Global and regional weather conditions are also expected to become more variable than at present, with increases in the frequency and severity of extreme events such as cyclones, floods, hailstorms, and droughts. By bringing greater fluctuations in crop yields and local food supplies and higher risks of landslides and erosion damage, they can adversely affect the stability of food supplies and thus food security.

3. Impacts of Climate Change on Food Utilization

Climate change will also affect the ability of individuals to use food effectively by altering the conditions for food safety and changing the disease pressure from vector, water, and food-borne diseases. The IPPC Working Group II provides a detailed account of the health impacts of climate change in its fourth assessment report. It examines how the various forms of diseases, including vector borne diseases such as malaria, are likely to spread or recede with climate change. This article focuses on a narrow selection of diseases that affect food safety directly, i.e., food and water-borne diseases. The main concern about climate change and food security is that changing climatic conditions can initiate a vicious circle where infectious disease causes or compounds hunger, which, in turn, makes the affected populations more susceptible to infectious disease. The result can be a substantial decline in labour productivity and an increase in poverty and even mortality. Essentially all manifestations of climate change, be they drought, higher

temperatures, or heavy rainfalls have an impact on the disease pressure, and there is growing evidence that these changes affect food safety and food security.

4. Impacts of Climate Change on Access to Food

Access to food refers to the ability of individuals, communities, and countries to purchase sufficient quantities and qualities of food. Over the last 30 years, falling real prices for food and rising real incomes have led to substantial improvements in access to food in many developing countries. Increased purchasing power has allowed a growing number of people to purchase not only more food but also more nutritious food with more protein, micronutrients, and vitamins. East Asia and to a lesser extent the Near-East/North African region have particularly benefited from a combination of lower real food prices and robust income growth. From 1970 to 2001, the prevalence of hunger in these regions, as measured by FAO's indicator of undernourishment, has declined from 24% to 10.1% and 44% to 10.2% respectively. In East Asia, it was endogenous income growth that provided the basis for the boost in demand for food, which was largely produced in the region; in the Near-East North African region demand was spurred by exogenous revenues from oil and gas exports, and additional food supply came largely from imports. But in both regions, improvements in access to food have been crucial in reducing hunger and malnutrition.

5. Impacts on Food Prices.

Essentially all SRES development paths describe a world of robust economic growth and rapidly shrinking importance of agriculture in the long run and thus a continuation of a trend that has been underway for decades in many developing regions. SRES scenarios describe a world where income address possible local production shortfalls through imports and, at the same time, find ways to cope with safety and stability issues of food supplies. It is also a world where real incomes rise more rapidly than real food prices, which suggests that the share of income spent on food should decline and that even high food prices are unlikely to create a major dent in the food expenditures of the poor. However, not all parts of the world perform equally well in the various development paths and not all development paths are equally benign for growth. Where income levels are low and shares of food expenditures are high, higher prices for food may still create or exacerbate a possible food security problem.

CONCLUSION

Climate change effects will affect all determinants of food security and unless effective adaptive responses are put in place agricultural yields are set to decline significantly at a time when increasing populations will demand more food. Organic agriculture could contribute significantly to reduce green house gas releases and sequester carbon in soils and biomass. Secondly, there is sufficient evidence that organic agriculture is superior to mainstream the agriculture. This is more even more important as the capacity of organic agriculture could contribute to mitigate the climate change can be considered as an ancillary benefit to its primary goal of sustainable land use. This primary goal is achieved by gain in soil productivity, consecutive food security, bio security conservation and many

other benefits. Adaptation strategies can help minimize negative impacts. These need research and policy support.

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Mastitis, Metritis, Agalactia (MMA)

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Mastitis, Metritis and Agalactia MMA) is a complex syndrome seen in female pigs shortly (12 hours to three days) after farrowing. Mastitis is a bacterial infection of the udder. In many cases only one or glands are acted-on metritis: An infection of the uterus, presented as vulval discharges agalactia: A being made less, or total loss, of milk producing by the female pig. Frequently not sensed until the giving/taking milk from mother bed make clear to signs of strong desire and/or weight loss.

Causes:

It is caused by a bacterial infection of milk-producing parts glands (udder) and/or the urogenital tract. MMA leads to increased young pig mortality and reduced separating weights.

Clinical signs:

As well as mastitis, metritis and agalactia, clinical signs join constipation, fever and anorexia (one to 2 days). Inappetence is often the first sign to be noted, in company with restlessness during suckling and a loss of condition in the bed. Small in number cases of MMA play or amusement all signs together and signs take care of to be farm-specific. In some cases low milk producing and sad, unhappy daily live weight profit of piglets may be the only an idea of the hard question.

Diagnosis:

Diagnosis is based on clinical signs, particularly inappetence in the female pig and a copies of smaller size in the condition of the waste. The udder can be palpated (touched) on both sides by running a hand under both lines of glands; person glands that are acted-on will have a feeling firm and burning taste. The existence of mastitis can be made likely by testing the milk; getting together will have need of oxytocin pumping in to stimulate milk let down. The bed should also be was looking at as diarrhoea , septicemia or hypothermia may lead to dropped intake of milk and a more than enough of milk in the udder , which could put into motion the drying off process.

Treatment:

Good draining will help keep female pigs clean and dry. You should always give expert opinion your vet for opinion on giving attention to MMA treatment usually includes the use of antibiotics and medical activities to reduce inflammation and pumping in products to stimulate milk producing. Small doses of oxytocin can help, although they

should not be necessary if piglets are suckling regularly; if used early on, oxytocin may reduce the need for veterinary input treatment should be given as soon as MMA is diagnosed or if female pig body temperature gets up above . The female pig should be supported to drink by regularly stimulating her to go higher.

Control and Prevention: The most effective prevention of MMA is good hygiene condition.

1. The farrowing pen and the sow must be kept clean and dry throughout the period to reduce bacterial challenges for effective cleaning and disinfection protocol
2. Sows that get more exercise before farrowing and in the early stage of lactation are less prone to MMA
3. Avoid slippery floors which are one of the main causes for reducing activity in lactating sows
4. Fat sows are more disposed to MMA due to excessive feed before farrowing
5. Make sure adequate water is available to sows at all the times especially lactating sows require 15 to 30 litres per day.

Importance of screening for genetic disorders in breeding cattle

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Recessive autosomal genetic disorders are found at very low frequencies in livestock, but they have a significant economic impact on livestock breeding and management. Most of the genetic diseases in domesticated species are inherited as autosomal recessive traits and carriers generally didn't show any phenotypic symptoms. The present breeding technologies especially artificial insemination (AI) has widespread application in bovine breeding programmes due to this reason undiagnosed genetic disorders might spread rapidly through the use of a carrier breeding bull's semen. It has become necessary to screen all animals to minimize the risk of spreading these diseases to next generation. Understanding the molecular basis of a genetic defect makes it possible to detect carriers directly at the DNA level and more important, early in the animal's life. The diagnosis method based on PCR and PCR-RFLP based analysis is more reliable and useful method for extensive screening for genetic disorders in breeding animals.

The known genetic disorders in bovines are

1. Bovine Leukocyte Adhesion Deficiency (BLAD)
2. Deficiency of Uridine Monophosphate Synthase (DUMPS)
3. Bovine Citrullinemia (BC)
4. Factor XI deficiency (FXID).

1. Bovine Leukocyte Adhesion Deficiency (BLAD)

BLAD is a lethal autosomal recessive genetic disorder which causes a reduced level of expression of the adhesion molecules on neutrophils called as β–integrins, a complex of CD 11/CD 18 family of proteins that helps the neutrophils to migrate to the site of inflammation (Nagahata *et al.,* 1987). BLAD is an economically important disease

emphasizing the need for genetic screening to eliminate the mutant allele from the population. This disorder is present Holstein breed worldwide. The defect was first identified in North American Holstein and was exported to other national Holstein. The carrier frequency of BLAD among US Holstein cattle once had reached to approximately 15% among active breeding bulls and 8% among cows. Besides, owing to the widespread use of top breeding HF bulls imported from the USA, many countries reported a high incidence of BLAD carriers in their black and white population (Pareek and Kaminiski, 1996; Lubieniecki *et al.,* 1999). The homozygous condition of this disorder will cause death in animals. BLAD is caused mainly due to point mutation (A→G) arisen at the position 383 in CD 18 gene located on the first chromosome of bovine, causes an aspartic acid to glycine substitution at amino acid 128 (D128G) in glycoprotein leading to the expression of a wrong protein (CD18) that is impaired in function. Animals with this disorder show symptoms as impaired wound healing and stunted growth, persistent marked neutrophilia, chronic diarrhea, ulcers on oral mucous membranes, chronic pneumonia, gingivitis, loss of teeth, high fever and other infections (Kherli *et al.,* 1990; Shuster *et al.,* 1992). There is also the existence of silent point mutation (C→T) at position 775 in the CD 18 gene (Shuster *et al.,* 1992) of bovines.

2. Deficiency of Uridine Monophosphate Synthase (DUMPS)

The enzymatic deficiency of Uridine-5-monophosphate synthase (DUMPS) is a lethal recessive genetic disorder that interferes with the biosynthesis of pyrimidines. UMPS gene is mapped in bovine chromosome 1 which transcribe and translate the enzyme catalyzes the conversion of orotic acid into Uridine monophosphate, precursor for all other pyrimidines and normal constituent of the milk in cow and other ruminants (Robinson *et al*., 1993). DUMPS is caused by point mutation of C→G in codon 405 of exon5 (Harlizius *et al*., 1996) in Dumps gene. Fetus homozygous for DUMPS does not survive in the uterus and usually die at early in gestation i.e early embryonic deaths (Ghanem *et al*., 2006). The embryos abort approximately 40 days after conception, leading to repeated breeding problems (Lee *et al*., 2002) in cows. This also leads to different intra uterine infections and subsequently causes the calving interval elongation in the herd.

3. Bovine Citrullinemia (BC)

Citrullinemia is an inborn metabolic disorder characterized by serious neurologic symptoms in newborn calves (Harper *et al*., 1986). It is caused by C86G transition within exon 5 in the gene coding for arginino succinate synthetase (ASS) enzyme which leads to an error of urea metabolism. This conversion results in a truncated peptide product (85 amino acids long rather than the normal 412 amino acids) that lacks enzyme activity. This mutation also eliminates a restriction site for the enzyme AvaII which will cut the normal gene but not cleave the mutant gene (Dennis *et al.,* 1989). It is characterized by high levels of citrulline, and more seriously, of ammonia

in plasma. Affected (homozygous) calves are unable to excrete ammonia and display neurological symptoms that become progressively worse, leading to death within one week of birth. After birth, these calves, display neurological problems that become progressively worse. Depression is observable within a day and signs shown as unsteady gait, head pressing, aimless wandering, apparent blindness, collapse, convulsions, and death within one week (Healy *et al*., 1990; Harper *et al.,* 1986).

4. Factor XI deficiency (FXID)

Blood clotting factor eleven deficiency is a monogenic recessive autosomal bleeding disorder. It is a major genetic defect affecting the reproductive efficiency of dairy cattle which causes increased susceptibility to infectious diseases, mastitis, metritis and pneumonia, low calving and survival rates (Liptrap *et al.,* 1995). Factor XI is an inherited deficiency which results in a bleeding disorder and also important protein involved in the blood coagulation. The causal mutation responsible for FXID is consists of the insertion of poly adenine tract (76bp AT(A)28TAAAG(A) 26GGAAATAATAATTCA) into exon 12 of FXI on chromosome 27 which introduces a premature stop codon leading to the synthesis of nonfunctional protein (Marron *et al.*, 2004).

PRECAUTIONS TO MONITOR THE GENETIC DISORDERS

1. Continuous screening of bull calves which are going to be selected on the basis of family selection for future breeding stock.
2. Continuous screening of young bulls before allowing them to Artificial Insemination (AI) stations is reducing the incidence of BLAD carriers among HF animals.
3. Trading of semen between the countries this genetic disease can spread to a large population as carrier animals.
4. Restricted breeding and long-term investigations have enabled a great reduction of this threat to the population.
5. India, where HF animals are extensively used for crossbreeding programmes, it has become necessary to screen all HF and their crossbreds to minimize the risk of spreading these diseases among future bulls and dams.

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Piglet Anaemia

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Anaemia causes ill care with money in piglets. Anaemic piglets are feebly colored and get together liquid (or gas) around the throat, meat from chest and inside body spaces. They are likely to scour and are readily moved to different other conditions and diseases. Anaemia is responsible for about 10% of pre-weaning deaths in attention less families of young animals.

Cause

Anaemia is a feeble amount of hemoglobin, the part of blood that transports oxygen through the body, and in piglets is caused by a not being enough of iron. Fresh after birth piglets have not enough iron in their systems to support pleasureable blood levels of hemoglobin until separating, and female pigs' milk provides only minute amounts of iron. Under natural conditions piglets may come to be enough iron from soil, but as piglets are now generally put up (structure) indoors on solid, special, fact, metal or made of wood floors without way in to soil, they have need of iron supplementation. Anaemia can also be brought on by blood loss through small hollow in front of body from birth producing blood. Small hollow in front of body from birth producing blood can be a got handed down ways special to a person, but is also connected with vitamin-K shortness of, and has been made observations in beds on sawdust or thin bits got off wood from preservative-treated wood. Quicker growing piglets have need of more iron to support the same level of blood hemoglobin than slower growers. Normal dose rates of supplementation cover this. The general direction to earlier separating has made lower, less the level of needed iron supplementation.

Diagnosis

Young pig anaemia is diagnosed by putting questions to unclotted blood examples and marks at post-mortem. By itself, the clear feeble coloring of pigs can be misleading and should not be was dependent on upon to diagnose anaemia. Treatment Piglets may get added iron from pumpings in, dosages by mouth or by other ways of doing. Once weaned, pigs will generally get enough iron in their diets. Pumping in pumping in piglets with iron dextran, iron galactan or other iron makes adjustment about payment of debt is the most common careful way of supplementation. The pumping in is most commonly given before piglets are 72 hours old. Move after the maker of goods of great scale by machines's teachings and inject into the muscle or under the skin. Sterilise

needles and syringes before use and clean the pumping in place. Keep from more than enough loss from the pumping in place by using a right measure of value of hypodermic needle. Piglets are frequently damaged skin but not broken at the pumping in place and pumpings in the leg can cause feebleness, increasing the chance of being inadvertently overlaid by the female pig. Iron makes adjustment about payment of debt can cause changing color of the muscle at the pumping in place and these areas do not drying, salting food rightly and are hard to discover. The fault is frequently only sensed by users, which lowers the image of a good quality product. A further hard question is the not frequent development of infections or abscesses at the pumping in place. These problems of feebleness, changing color and infection are made less if piglets are pumped in the neck behind the ear rather than in the leg.

Injection technique

When pumping in into the neck, turn the pig's head away to one side to stretch the skin and muscle at the pumping in place. After pumping in, place your thumb over the place and let the pig's neck to straighten. This helps put a stop to the amount of medical substance given leaking from the pumping in place. In a different way, with the young pig kept between the left angle of arm and body, the left hand is used to pull the piglets right ear forward, making open to and stretching the skin of the neck. The needle is used to push the skin forward, and then is pushed into the muscle. The needle is taken away and ear released at the same time. Pushing the skin forward before the pumping in helps put a stop to amount of medical substance given loss. The most right needles to use are 18 fixed size and 12 mm 2, or 20 measure of value for thinner liquids. Subcutaneous (under the skin) pumpings in can be given over the rib wire house.

Oral dosage

Necessary part of a system iron in a preparation with iron galactan given to fresh after birth piglets within 18 hours of birth, keeps out of many of the problems of iron pumpings in. changing color, feebleness and infections are took away but the preparation is more high in price. Piglets must be amounts given at one time within 18 hours of birth as iron galactan is only taken up from the gut very early in living; similar to the being taken up of colostrum. Piglets should let into one's house the full recommended dose and a second dose should be given if the first is regurgitated. It is unwise to get support from on this careful way if piglets are scouring as being taken up through the gut is likely to be less good at producing an effect. Use that possibly taking place in addition preparation if 18 hours has gone by. In some piggeries, anaemic piglets have been seen even though they have been amounts given at one time with iron galactan. The most likely causes are ill-timed the government, wrong giving medical substance way of doing or early scouring. There have been reports that orally controlled iron can itself cause scouring, through the thing giving greater value to of bacterial growth in the gut. Inorganic iron may be given to piglets orally to put a stop to anaemia. Limited amounts are taken up daily through the gut wall so redone the government is

necessary. Compounds such as ferrous sulphate are cheap, but have need of redone doses, increasing time and labour.

Other methods

Iron makes adjustment about payment of debt, uncontaminated soil or both may be full of droplets in farrowing small shut-in places for animals, and the statement in law of go with body near earth get food to with a high-iron What is in can be useful. It has also been stated that piglets can come to be iron by licking uncovered steel fittings in farrowing small shut-in places for animals and from plant udders coated with iron makes adjustment about payment of debt. Getting lifted up, higher iron levels in lactating female pig special food can come out in beds letting into one's house more iron, but the starting point is not the plant's milk but her animal waste. Although these other methods are important enough backups, person giving medical substance is able to be put before as it makes certain that all piglets let into one's house the iron supplement.

Uniferon®

Uniferon® (iron dextran) has an advanced high quality injectable iron for prevention and treatment of iron deficiency anaemia in piglets. Uniferon® may be administered on the 1st to 3rd day of the piglets life and offers a full 200 mg iron dose in only 1 ml injection for good health, optimum growth and increased resistance against diseases.

Secondary agriculture in India: Scope and potentials

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ABSTRACT

Agriculture is the way of life for majority of population in India. After Independence, due to sincere efforts made by agricultural system in India, It has nearly achieved self sufficiency primary agriculture (Grains,s ugarcane, fruits, vegetables and milk).But the level of processing and value addition is very low and post harvesting losses are very huge in our country when compared to other developing and developed countries. Now the country should give more emphasis on value addition to primary agriculture. In India there is a lot of scope and potential for promotion of secondary agriculture since its economy depend on primary agriculture. Secondary agriculture has tremendous potential for creating infrastructure and jobs in rural areas.

Agriculture is the backbone for Indian economy. But since two decade, India is going through an economical and social transformation. In this process of transformation includes transit from an agriculture based economy to a commodity and service based economy. Since, so many decades entire Indian agricultural system has been made enormous efforts to enhance productivity in agriculture and allied sectors. As a result, India has witnessed green revolution in food grains, white revolution in milk, golden revolution in fruits and vegetables, yellow revolution in oil seeds and blue revolution in fisheries and looking forward for achieving rainbow revolution, covering entire spectrum of activities in agriculture and allied enterprises. Having achieved near "self –sufficiency " in primary agriculture, India must now focus its attention on secondary agriculture. i.e adding value to the basic agro-commodities to allow farmers to get better returns. An equivalent growth in the both the primary and secondary agricultural sectors are needed for agriculture development in India. In fact both primary and secondary agriculture sectors are interlinked and complementary to each other.

Secondary agriculture: value addition to primary agriculture

The secondary agriculture means value addition to agricultural produce through creating facilities for processing at various levels to allow farmers to get better returns from their harvest. Examples of secondary agriculture are vitamins from grains, oil from rice bran, starched sugar from corn, milk and protein from soybean, industrial

chemicals and bio-fuel from sugarcane and ligno-cellulosic biomass, fiber board from rice straw, high value animal by products, in addition to medicinal plants and herbal products not yet fully capitalized in India.

Value addition is often understood in the context of adding value to the product. A new dimension from the consumer point of view is added to the existing understanding of value i.e. how a consumer perceives the value delivered to him through a bundle of product services. This new approach of value addition through the consumer's mind needs special attention. All the activities now must be seen from the consumer point of view. In other words, consumer orientation is required in all spheres of agricultural sector. Keeping this approach in mind, there are three ways in which value addition to farm produce is possible:

Various activities which add value to produce from primary agriculture can be broadly classified as follows:

Post harvesting Level: The activities carried out at post harvesting level which includes cleaning, sorting, drying, grading bagging and packaging. Eg: drying of food grains,grading of vegetables.

Primary processing: Primary processing is the conversion of raw materials to food commodities. Eg: Dehulling and milling of grains, Packing of Atta, Processing of grains into flakes,ravva,suji etc

Secondary processing: Secondary processing is the conversion of ingredients into edible products – Eg: Baking of cakes, Biscuits etc.

Tertiary processing: processing which involves complex, high end technologies and infrastructure for obtain diversified products from agricultural commodities.

Eg: Extracting Lipase enzyme from wheat germ, phytate derivatives from cereal grains etc.

Potentials of secondary agriculture:

Secondary agriculture can add two to three-fold value to primary agriculture. For eg., starch from cereals, vitamins from fruits, oil from rice bran, starched sugar from corn, milk and protein from soybean, industrial chemicals and bio-fuel from sugarcane and ligno-cellulosic biomass, fiber board from rice straw etc. The various potentials of secondary agriculture are as follows:

- Secondary agriculture has enormous potential at different niches of crop production ranges from cultivation of cash crops, production organic farm products, medicines, bio fertilizers, enzymes, fibres, starches, proteins, beverages, chemicals, bio fuels ,cosmetics etc.
- Secondary agriculture not only promotes agriprenuership in rural areas but also creates employment opportunities in rural areas.
- It also strengthens rural economy by promoting agro-based industries.
- The secondary agriculture is considered as a sunrise sector for the Indian economy, owing to its immense untapped potential.
- It promotes organic , agro-based and bio degradable products.

Scope for secondary agriculture in India

Since Indian is an agrarian country there is a lot of scope for value addition of produce from agriculture and allied sector produce. The country has second largest country under cultivation and highest area under irrigation (55.8 million hectares). India is demographically blessed with 15 major climates of the world, snow bound Himalayas to hot humid southern peninsula; Thar Desert to heavy rain areas all exist in India. There are 20 agro-climatic regions and nearly 46 out of 60 soil types in the country. Sunshine hours and day length are ideally suited for round the year cultivation of crops. India has rich biodiversity in plants, animals, insects, micro-organism and accounts for 17% animal, 12% plants and 10% fish genetic resources of the globe. In the live stock sector, India has 16% of cattle, 57% of buffalo, 17% of goats and 5 % of sheep population of the world. India is the second largest producer of rice and wheat in the world; first in pulses and fourth in coarse grains. India is also one of the largest producers of cotton, sugar, sugarcane, peanuts, jute, tea and an assortment of spices. The country is now second in production of cereals like Wheat, second in production of vegetables next only to China, first in livestock population with 18% of world's cattle population with and 13% of world's total milk production is contributed by India. Fifth largest producer of eggs and sixth largest producer of fish . In addition to this, there has been considerable changes in the patterns of production, consumption and the trade in Indian agriculture providing ample scope for value addition primary agriculture.

Initiatives and Incentives in Promoting Value Addition:

Government of India envisaged the need for secondary agriculture in 12 th five year To bring this vision into reality there is a need to strengthen the infrastructure for food processing sector with integrated supply chain, storage, preservation and marketing facilities. In this regard, government has taken up few remarkable initiatives like establishment of mega food parks, creation of integrated cold chains, modernization of abattoirs, quality control laboratories, and R and D, human resource development and capacity building through the establishment of National Institute of Food Technology, Entrepreneurship and Management (NIFTEM) and Indian Institute of Crop Processing Technology (IICPT). Government also enacted an integrated food law through Food Safety and Standards Act and set-up Food Safety and Standards Authority of India (FSSAI) to implement the provisions of the Act.

Institutions Working For Development of Value Addition:

There are several institutions working under government of India to have control over these industries, meanwhile these institutions helps to increase extent of value addition in agro-processing sector. Some of the important institutions are-

1. MOFPI: Ministry Of Food Processing Industry
2. APEDA: Agricultural and Processed Food Products Export Development Authority
3. FAIDA: Food and Agricultural Integrated Development Authority
4. MPEDA: Marine and Processed Food Products Export Development Authority

5. CFTRI: Central Food Technological Research Institute
6. NDDB: National Dairy Development Board
7. SEAI: Solvent Extraction Association of India
8. CIFTI: Confederation of Indian Food Trade Industries
9. AIFPA: All India Food Packers Association
10. FICCI: Federation of Indian Chamber of Commerce and Industries
11. EIC: Export Inspection Council
12. ASSCHAM: Associated Chamber of Commerce and Industries.

CONCLUSION

Secondary agriculture has tremendous scope in Indian context due to its demographic, situational and socio economic characteristics. Value addition to primary sector not only creates new jobs in rural areas but also opens new avenues for rural industries and infrastructure. By realizing the enormous potential of secondary agriculture, government of India has been implementing various programmes under different ministries for promotion of agro-based enterprises. Hence, there is an immense need to build the capacities of aspiring entrepreneurs to take up initiatives in secondary agriculture sector.

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Latest developments in crop management

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Integrated Crop Management (ICM) is a common sense approach to farming. It combines the best traditional methods with appropriate modern technology, balancing the economic production of crops with positive environmental management. Basic concept of ICM is crop management, nutrient management, pest management, and financial management. Each of these components of ICM is associated with agricultural **Best Management Practices(BMP).**

Definition: "ICM is a method of farming that balances the requirements of running a profitable business with responsibility and sensitivity to the environment. It includes practices that avoid waste, enhance energy efficiency and minimise pollution. ICM combines the best of modern technology with some basic principles of good farming practice and is a whole farm, long term strategy".

ICM is a 'whole farm approach' which is site specific and includes: The use of crop rotations, appropriate cultivation techniques, careful choice of seed varieties, minimum reliance on artificial inputs like fertilizers, pesticides etc., maintenance of the landscape and the enhancement of wildlife habitats.

Latest technologies developed in crop management:

Green manure or green leaf manure applied @ 6.25 t/ha to rice soil and incorporated before transplanting had reduced the loss of nitrogen by about 13 kg/ha which otherwise would have lost through volatilization and leaching as was observed in rice soil not applied with either green manure or green leaf manure. Urea when mixed with gypsum and neem cake in the ratio of 5:4:1 and kept for 24hrs prior to application in a rice soil, had showed down the dissolution rate of urea granules and reduced the losses of nitrogen by about 8kg/ha. Rice husk ash(by produce of rice mills)when applied to thaladi crop twice (during cold weather period) @ 1t/ha per application, had increased the rice grain yield by 10% over control. In direct seeded semidry rice (CR1009),spray of 1% Fe SO_4 and 0.5% Zn SO_4 solution thrice during tillering, panicle initiation and grain filling stage had increased the rice grain yield by 14% over control and 8% over the application of Zn SO_4 and Fe SO_4. Combined application of Azospirillum and Azolla to rice soil had recorded the highest rice grain yield of 5.28t/ha during thaladi season.

Iron deficient soils require 50 kg Fe SO_4 /ha along with NPK for higher rice grain productivity. In rice crop, for chlorophyll meter(SPAD) based N application, the SPAD value 35 is optimum for kuruvai season and 37 is optimum for thaladi season to get higher grain yield with greater nitrogen use efficiency. Site Specific Nutrient Management(SSNM) always produced a higher grain yield with higher NUE and soil nutrient supplying capacity. Therefore .the farmers can be advised to adopt judicious N fertilizer application based on soil N supplying capacity.

Sustainable Sugarcane Initiative (SSI):

SSI is a method of sugarcane production which involves using less seeds, less water and optimum utilization of fertilizers and land to achieve more yields. Driven by farmers ,SSI is an alternative to conventional seed, water and space intensive sugarcane cultivation.

Principles in SSI:

Raising nursery using single budded chips, Transplanting young seedlings (25-35 days old), Maintaining wide spacing (5x2 feet) in the main field, Providing sufficient moisture through water saving efficient irrigation technologies viz, skip furrow alternate furrow and subsurface drip irrigation, Practicing intercropping with effective utilization of land,

Water management:

Produce more per mm of water and all other inputs, Raise cane crop even under marginal lands, Raise crop in problem soils and water, Minimum tillage, Create micro catchments for water harvesting, Multi ratooning, and Produce higher cane yield with less water.

Table No.1: Comparison between Conventional and SSI methods of sugarcane cultivation:

Particulars	Conventional method	SSI method
Seeds/Setts	48000 buds(16000 three budded setts)	5000 single budded chips(5000 buds per acre)
Nursery Preparation	No	Yes
Planting	Direct planting of setts in the main field	Transplanting of 25-35 days old young seedlings raised from bud chips
Spacing	1.5 to 2.5 ft between rows	5 ft between rows
Water requirement	More(flooding of field)	Less (maintenance of the moisture in the furrows and adoption of drip irrigation)
Mortality rate	High	Low
No.of tillers per plant	Less(10-15)	More (15-20)
Accessibility to air and sunlight	Low	High
Scope for intercrop	Less	More

Overall benefits of SSI

In conventional method, cost of setts occupies the major part of cost of cultivation, By practicing SSI, this seed cost can be reduced up to 75%, Reduction in the plant mortality rate, Increases in the length and weight of each cane, It is easy to transport the young seedlings for longer distance, Intercultural operations can be carried out easily due to wider spacing

Opportunities offered by SSI

Addresses the issue of late planting by raising seedlings and their transplantation later on which actually advances the entire process. Addresses the issue of narrow spacing as the technology is based on successful exploitation of sunlight and air by following wider spacing in the main field. Addresses the problem of improper method of irrigation, namely flooding, and Significant reduction in seed requirement, as only the bud is used as seed material.

SSI involves use of less seeds, less water and optimum land utilization to achieve more yields. It is governed by some principles like using single budded chips, raising nursery, wider spacing, sufficient irrigation, and intercropping. The direct benefits out of these practices are , better germination percentage, high number of millable canes, reduction in the crop duration to some extent, increased water use efficiency, improvement in accessibility to nutrients with optimum use of fertilizers, more accessibility to air and sun light, reduction in cost of cultivation and extra income from intercrop. On the whole, by practicing SSI ,farmers can very well increase their productivity by reducing the use of inputs like fertilizers and saving the vital resources like water simultaneously. Hence, it is very much possible for sugarcane farmers to reap greater economical benefits by maintaining ecological sustainability.

Organic Farming

An alternate agriculture method without chemicals, by using natural inputs such as organic manures, vermicompost, biofertilizers and biological inputs for pest and disease management.Organically certified products attracts more price in the domestic as well as in the global market.

Key role of Organic Farming

Protect the long term soil fertility level by maintaining organic matter level by encouraging soil biological activities with careful mechanical intervention. Improved NUE by applying biofertilizers, legumes in cropping ,effective use of organic wastes like crop residues and livestock manures. Through crop rotation minimizing the pest, disease and weeds by natural predators, organic manuring, and using resistant varieties. The extensive management of livestock, paying full regard to their revolutionary adaptations, behavioural needs and animal welfare issues with respect to nutrition, housing, health, breeding and rearing. Careful attention to the impact of the farming system on the wider environment and the conservation of wildlife and natural habitats.

Precision Farming

A site specific farming which involves advanced agro technologies applied at quantity, at right place, at right time including drip irrigation for maximizing crop yield.

Components of Precision Farming

Geographic Information Systems(GIS),Global Positioning Systems(GPS),Grid Sampling, Variable Rate Technology(VRT),Yield Monitor and Sensors.

Benefits of Precision Farming

Better estimation of the real need of the crop, More accurately predict the crop yield, Increase the output and / or reduction of input, Better planning and time management agricultural activities, Apply insecticides the places where insect problems exist only, Helps farmers set an history of his farm practices and results and Help the farmers in his decision making and traceability requirements.

Dry Land Technologies

Soil moisture is the most limiting factor in dry land agriculture. Evaporation has to be arrested as it is not directly related to productivity where as transpiration can be reduced to some extent without affecting productivity of plants. The evaporation losses can be reduced by applying different types of mulches, anti-transpirants, shelter belts, wind breaks and weed control.

Dry land agro techniques

Forming ridges and furrows across the slopes, random tie ridging, tie ridging, forming trenches across the slope, developing the small farm pond to collect the rain water and recycle the water, mixed cropping components, mulching methods etc.,

Pulse Production Technologies

The recent technologies to increase the pulses productivity are using the quality and certified seeds, growing yellow vein mosaic resistant varieties, using biofertilizers for seed treatment and in the main field, using suitable herbicide application, maintaining optimum plant population, applying recommended level of fertilizer doses, spraying of 2% DAP foliar application during flowering and pod formation stages, adopting suitable measures for pod borers, and cultivating pulses as in sole, inter and mixed cropping systems.

Oil Seeds Production Technologies

The following methodologies are adopted as screening techniques for developing pests and disease resistant varieties development in sunflower, castor and groundnut. Developments of gene constructs for cloning and construct design on oil seeds crops. Bio intensive IPM strategies are being deployed on oilseeds crops. Hybrids development on sunflower, caster, groundnut and other oil seeds crops through intensive research. Providing training to extension workers and farmers on microbial bio control agents of major pests and diseases of oil seed crops.

Millets Production Technologies

The recent research focussed on production of millets hybrids to produce higher yield and to produce pest and disease resistant varieties or hybrids. The research from ICRISAT focussed on improving the nutritional standards millets (sorghum, cumbu, maize) to meet out the developing countries need and to withstand the drought and moisture stress.

Forage and Fodder Production Technologies

The propagation of fodder and forage crops are primarily through seeds, recent research studies focussed on vegetative propagation like stubble cuttings in various length were carries out and yields better results in short duration with higher biomass production in the case of cumbu napier grass and in fodder sorghum. Research on hydrophonic system conducted on Alfalfa, Barley, Cowpea, Sorghum, and wheat. The total biomass produced are recorded in one cycle (8 days) resulted higher side on cowpea, alfalfa, barley followed by sorghum and wheat.

Organic cotton

In organic cotton cultivation, the seed rate used as 25 kg/ha with the spacing adopted as 75 x 15 cm and the population maintained as 85-90 thousand plants per ha. One row of fodder cowpea (*Vigna anguiculata*)should be drilled between two rows of cotton. This crop could be ploughed down and burried in soil just before its flowering and the manures used are FYM, compost and vermicompost. The fodder cowpea contributes 400-500 kg of dry matter per ha and provides 10-12 kg N/ha during squaring, and smothers weeds, controlling seasonal soil erosion, and nurturing natural enemies of cotton pest.

Bt Cotton

Bt cotton is genetically engineered form of natural cotton. The main advantage of utilizing biotechnology in agriculture are the possibilities of increase in productivity through the use of newer varieties that posses properties such as pests, diseases and other stressful conditions like drought, salinity or water logging . The above benefits can be imparting to the normal crop through the transfer of a gene from Bacillus thuringiensis (Bt) into target plants eg. cotton by modern biotech methods.

Remote sensing and GIS in crop production

To predict climate change and to prepare crop modelling. To study the land surveying through satellite images. To study the various agro climatic zones prevailing vegetations and to propose for future cropping schemes. To calculate the accurate areas under cropping , forestry, water bodies, irrigation catchments, and irrigation coverage areas under each command areas. To study the ground water potentials, river basins, deserts and oceanic environments. To study about the natural calamities affected areas, relief action coverage, and natural calamities prediction too. To get the image interpretation

normally we use both supervised and unsupervised methods for digitizing the satellite data images.

The Components of Integrated Farming Systems

Cropping with livestock, birds, and trees. Cropping of mono, inter, mixed, multiple, multi-tier components are introduced according to the resource availability. The crop components like cereals, pulses, oil seeds, forage crops, fibre crops, sugar crop and commercial crops like tobacco, turmeric were also introduced. Livestock components like mich cows, goats, sheeps, poultry, honey bees, fish culture and mush room culture were also introduced.

The Benefits of Integrated Farming Systems

This system is a whole farm approach where in all the farm available resources are fully utilised and recycled Additional farm revenues are generated due to integrated allied components and there by additional man days were developed. Through this approach soil fertility and soil productivity levels are improved. Reduction in the usage of artificial inputs to the farm and this is being a fine tuned approach towards eco friendly and environmental protection.IFS systems were developed for different agro climatic conditions in the country to generate more income to the farmer as in the whole farm approach.

Urolithiasis in Buffalo Calves: A Growing Concern For Buffalo Farmers

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Abstract

Dysuria and anuria due to formation of calculi in the urinary tract have been one of the most common surgical affections of buffalo calves during the winter months. Mortality among the affected buffalo calves have been high even though new treatment modality have been introduced. This is because of the delayed presentation of buffalo calves for surgical intervention because of the failure of famers to identify the clinical signs early due to lack of information about the condition and the available treatment options. Moreover the incidence of obstructive urolithiasis can be reduced greatly by various managemental practices. The present article aims to educate the farmers about the urolithiasis in buffalo calves, its occurrence, predisposing factors, treatment and various managemental practices to reduce its incidence.

INTRODUCTION

Urolithiasis refers to the formation of calculi in the urinary system that obstructs the kidney, ureter, urinary bladder and /or urethra. Retention of urine due to formation of urinary calculi in buffalo calves have been a growing area of concern for the buffalo farmers as it leads to considerable economic losses due to treatment, morbidity and mortality.

Incidence

Urolithiasis occurs in all species of animals but is most commonly seen in buffalo calves throughout the country with maximum occurrence being reported in northern side of India which may be due to the large size buffalo population spanning the northern part. Urolithiasis occurs in both male and female calves but the incidence of obstruction due to calculi is lesser in females because of the shorter length and higher flexibility of urethra due to absence of tunica albuginea. Castrated male calves are at higher risk when compared to intact male and female calves.

Predisposing Factors

Urinary calculi can occur in any part of the urinary tract but in buffalo calves mainly the urethra is affected. The urinary calculi gets lodged mostly in the sigmoid flexure or at the glans penis or even these can obstruct the neck of the bladder also.

A number of factors have been considered as the causative agents predisposing the animal to formation of urinary calculi. Restricted and reduced availability of water and feeding of phosphorus rich diet immediately after weaning areconsidered as the major factors whereas lack of vitamin A in the diet and early castration of male calvesare regarded as minor factors.

Majority of the incidences of obstructive urolithiasis have been particularly reported in the winter months because of the reduced intake of water as well as reduced availability of water due to freezing. Feeding of phosphorus rich diet like wheat bran and rice bran leads to increased excretion of phosphorus in urine which along with reduced intake of water during winter months causes the precipitation and crystallization of minerals in the urine leading to calculi formation. Scarcity of green fodder is also considered as one of the predisposing factor as it leads to deficiency of vitamin A, which is required for maintaining the epithelium lining the urethra. The deficiency of vitamin A causes epithelial sloughing resulting in the formation of a nidus/nucleus for calculi formation.

The development of urethra and the surrounding muscles occurs under the influence of testosterone hormone. Early castration declines the testosterone level and causes improper development of urethral lumen because of which the calf will not be able to expel even the smallest calculi formed.

Clinical Signs

Urolithiasis leads to obstruction in the passage of urine. The first clinical sign to be noticed by the owner is the dribbling of urine and a reduction in the quantity of urine been excreted from normal.This is followed by painful efforts and straining while urination. Further the obstructions can be classified into partial or complete. Partial obstruction of the urethra is characterized by dribbling of urine evincing pain and with straining and propulsive motions of the penile urethra.

Complete obstruction of urethrais more harmful as compared to partial obstructions as it can lead to rupture of the urinary bladder and/or urethra due to continuous straining efforts for urination (Fig.1). Complete obstructions are characterized by anuria and distended abdomen (water belly appearance) which can give temporary relief to the animal but at the same time creates uro-abdomen leading to secondary consequences like peritonitis, urine scalding, subcutaneous seepage of urine and even death due to uraemia (Fig.2). Treatment should be given immediately after the first signs are observed to avoid such complications.

Diagnosis

Cases of obstructive urolithiasis can be diagnosed primarily on the basis of clinical signs itself. Ultrasonography can be employed to identify the calculi obstructing the urethra and the bladder. Paracentesis of abdomen can confirm the bladder rupture. Elevated blood urea nitrogen and serum creatinine level can also be used as diagnostic aids.

Treatment

Traditionally urethrotomy was followed but it was associated with many drawbacks like stricture formation due to fibrosis at surgical site and impairment of penile function due to damage to the cavernous muscle. Modern practice advocates tube cystostomy using Foleys catheter along with administration of ammonium chloride as the treatment of choice in cases of obstructive urolithiasis (Fig.3). Cystorrhaphy is undertaken if bladder is ruptured. This technique of tube cystostomy is safe, less expensive and less time consuming with lesser drawbacks when compared to traditional urethrotomytechnique. However tube blockage by calculi and displacement of tube by the animal itself can occur with this technique which is a managemental problem.

Along with tube cystostomy per oral administration of ammonium chloride at 500mg per kg body weight for 10-15 days is essential. Administration of ammonium chloride changes the pH of the urine that dissolves the calculi formed in the system as well as avoids the formation of new calculi.

Prevention

Various managemental practices can reduce the incidence of formation of calculi. Adequate and continuous availability of water during the winter months and avoiding feeding of phosphate rich diets like brans immediately after weaning reduces the occurrence. Moreover providing adequate green fodder diet supplies vitamin A required to maintain the epithelium lining the urinary tract. Finally farmers should constantly monitor their calves for any signs of urinary obstruction and should provide early surgical intervention if signs are noticed.

Figure 1 Ruptured urinary bladder sue to complete obstruction

Figure 2.Urine scald and subcutaneous seepage of urine

Figure.3. Tube cystostomy using Foleys catheter

Mobile Veterinary Unit (MVU): A unique way to reach the poor at their doorstep

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Abstract

Livestock service delivery directly or indirectly affects livestock productivity. Government run livestock service delivery has been facing formidable challenges from multiple sources. Many government initiatives has been taken worldwide to come over the constraints viz. collaboration between public health and veterinary services in Africa including developing countries like India promotion of community based animal health workers (CBAHWs) in Africa, Afghanistan, and Kenya & training of local community people (Gopal Mitras) regarding artificial insemination (AI) practices and minor symptomatic treatment in India. Government of India is trying hard to come over the constraints of livestock service delivery through many unique and alternative ways. One of the ingenious ways of livestock service delivery at farmers' doorstep is through Mobile Veterinary Units (MVUs), which is functional in many states of India including Odisha. MVUs under *Rastriya Krishi Vikas Yojana* (RKVY) are operational in all the 314 blocks of Odisha and solving the purpose of the rural poor farmers who cannot pay to bring their animals to hospitals. Adoption of similar type of model in other states will be a great initiative to strengthen the livestock service delivery in real term.

Key words: Mobile Veterinary Unit (MVU), *Rastriya Krishi Vikas Yojana (RKVY)*

SCENARIO OF LIVESTOCK SERVICE DELIVERY IN INDIA

Livestock services have largely remained government funded activity under Indian context. In majority of Indian states, State Departments of Animal Husbandry are the major livestock service providers. The total number of veterinary hospitals/polyclinics in India was 11367 as on 31.03.2015 (DAHD&F). Though NCA (1976) had recommended one veterinarian for every 5000 cattle unit and one veterinary institution for four villages, but it is estimated that one veterinary institution exists for 11 villages covering about 62 sq. km

area (VCI, 2008**)**. There are 45211 veterinarians and paraveterinarians in the country (OIE, 2010) having the geographical presence of 0.0138 per square kilometer and 1.16 per 10000 Livestock Standard Units (LSU250 kg livestock standard unit, calculated on the basis of average weights of different species). On an average one veterinarian exists for every 7000 animals in India. In some states, situation is quite dismal with every veterinary clinic being situated at distance of more than 25 km away from villages**.** The ratio of livestock unit per veterinarian has increased further over the years. Even the vast government infrastructure for veterinary services, suffers from several public sector constraints. Due to these constraints (Shweta, 2014, Chander and Rathod, 2013; Pratap *et al.* 2012), the availability and effectiveness of public veterinary services has been limited, which has led to shift in service delivery from public towards the private and cooperative sector. A number of studies have suggested that government should provide more emphasis towards livestock service delivery system. Effective and efficient livestock delivery system has become a subject of rising concern to many national and international organizations including FAO (Verma, 2012).

REASONS FOR POOR LIVESTOCK SERVICE DELIVERY:

From the early 1990s, livestock services have been facing some daunting challenges in terms of operation in a continually changing policy, institutions and commercial environment under liberalization. With increasing financial constraints, concerns are also being raised about the efficiency and effectiveness of the government run livestock services along with extension activities. This coupled with the diverse demands placed by the farmers led to the search for alternative mechanism of providing these services.

In many underdeveloped and developed countries in Asia and Africa, it became clear that the government agencies are not efficient to provide quality and all inclusive diversified livestock health and management services (de Haan and Niessan, 1985). Macroeconomics adjustment policies are being implemented by various developing countries to reduce the government spending and to reduce national debt and budgetary crunch (FAO, 1997) which have accelerated the process of limiting the role of government in provision of several services (Sulaiman and Sadamate, 2000). May be fiscal constraints or lack of awareness and interest among government personnel or lack of proper monitoring at each step by government or all the factors jointly are responsible for poor delivery of veterinary services, to found out that still a bunch of research reports are required.

Due to poor livestock service delivery some animals suffer from diseases internally that lead to poor and low quality output. So we are facing problems in export of livestock products in particular. Ever since the World Trade Organization (WTO) agreement came into force in 1995, India has been under pressure to improve the delivery of livestock services, which is a prerequisite to face the changing domestic and foreign consumers and

to meet the standard outlined in the Agreement on Agriculture (AoA) through sanitary and phyto-sanitary measures (Thiermann, 2004).

EFFORTS OF GOI TOWARDS STRENGTHENING LIVESTOCK SERVICE DELIVERY:

Several reforms have been proposed to strengthen the livestock service delivery system by extending it to the rural poor in developing countries including India, viz. collaboration between public health and veterinary services in Africa, promotion of community based animal health workers (CBAHWs) in Africa, Afghanistan, and Kenya & training of local community people in the name of Paravets, *Gopal Mitras and pashu sakhi* etc. regarding artificial insemination (AI) practices and minor symptomatic treatment in India. One of the largest dairy cooperatives in India, Anand Milk Union Limited (AMUL) had initiated provision of livestock services to the farmers' doorstep through mobile veterinary dispensaries since 1950s. The concept of Mobile Veterinary Dispensary is now functional in many states of India like Karnataka, Tamil Nadu, Andhra Pradesh, Odisha, Arunachal Pradesh, Meghalaya, Rajasthan, Gujarat, Madhya Pradesh, and Chhattisgarh under different names like mobile veterinary clinic, ambulatory clinic, etc. The MVU in Odisha is a very good step of government in Odisha through RKVY programme to broaden the service delivery in the context of requirement.

(i) Mobile Veterinary Unit (MVU): An alternative to doorstep livestock service delivery

The concept of MVU has probably been originated from successful medical service delivery through Mobile Health Unit (MHU) in different parts of India.

A Mobile Veterinary Unit is needed in areas such as

- ✓ The areas which are remotely located from veterinary institutions
- ✓ Where availability of veterinary services are rare
- ✓ Inadequate transport facilities and difficulty terrain

In fact, Mobile Veterinary Services have become quite common in India. Many Indian states such as Karnataka, Tamil Nadu, Andhra Pradesh, Odisha, Arunachal Pradesh, Meghalaya, Rajasthan, Gujarat, Madhya Pradesh, and Chhattisgarh provide door step veterinary services through MVU or ambulatory clinics. In the state of Odisha, the concept of MVU was initiated on 10th July, 2011 as targeted service delivery mechanism in the state under National Agricultural Development Scheme or *Rastriya Krishi VikasYojana* (RKVY). Initially the scheme began in 10 tribal districts. Later on it was expanded and now it covers all the 314 blocks of the state. The aim of MVU is to ensure the desired veterinary services in interior pockets according to the preferred time of the farmers, so as to enable livestock owners and consider Animal Husbandry (A.H) activities as potential livelihood option and maximize profit through livestock rearing.

(ii) How does a MVU operate?

In MVU, team of professionals comprising one veterinary surgeon (V.S), one livestock inspector (L.I) and one attendant reach out to organize animal health camps in otherwise

inaccessible remote locations. The total working days for a MVU in a month are 20 days. In each working day, the team organizes one camp, which caters to the livestock owners of a minimum of two villages. The camps are organized on normal working days i.e. Monday to Saturday. Weekly 2 days are off so total holidays are 8 in a month. The rest two days are for monthly report and meeting.

(iii) Objectives of MVU

Objectives of MVU team are

- To provide door step veterinary services
- To educate people to adopt appropriate modern technology for improving livestock productivity
- To make surveillance and monitoring of livestock and poultry diseases
- To control and contain anthrax
- To popularize the use of herbal preparations for treatment & control of various livestock diseases
- To create awareness on livestock preventive health care by organizing extension activities (DAHVS, Odisha)

(iv) Monitoring and supervision of MVU

The overall responsibility of monitoring of functioning of MVU lies with Chief District Veterinary Officer (CDVO). Further, he has to report district collector from time to time regarding this. The SDVOs, ADVOs as well as the Block VAS/AVAS monitor the MVU activities as per the proposed tour schedule.

CONCLUSION

MVU is a relatively new and unique concept of alternative livestock service delivery mechanism, functional in some of Indian states but still many states are lagging behind in adopting this unique way of doorstep livestock service delivery to effectively promulgate the livestock services to the ultimate users. An effective policy formulation by Government of India to strengthen the Mobile livestock service delivery will definitely solve the purpose of farmers and will help in increase the national livestock production and productivity and will directly affect national economy.

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Necessitation of iron supplementation

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'Hidden hunger' is a term used to describe human deficiencies of key vitamins and minerals, also known as micronutrients. While global in scale, the prevalence of micronutrient deficiencies is particularly high in South Asia despite recent successes in economic growth, agricultural output and health care. According to Harding *et al.* 2017, more than 2 billion people worldwide, including women, children, the middle-aged, and the elderly are suffering from vitamin and mineral deficiencies, primarily iodine, iron, vitamin A and zinc. Iron deficiency also leads to anemia that is already affecting over half a billion people worldwide. During the 20th century, conventional plant breeding resulted in increased yields and harvest stability. Major research objectives in the past few decades have concentrated on increasing resistance to environmental stresses, pests and pathogens. But simply providing more food will not completely solve the problem of incomplete diets, therefore focus should be set on the quality and diversity of crops.

NUTRITIONAL IMPORTANCE OF IRON (FE)

Iron is a mineral vital to the proper function of hemoglobin, a protein needed to transport oxygen in the blood. Iron helps to preserve many vital functions in the body, including general energy and focus, gastrointestinal processes, the immune system, the regulation of body temperature, deoxyribonucleic acid (DNA) synthesis, and electron transport (Table 1). The benefits of iron often go unnoticed until a person is not getting enough. Iron deficiency anaemia can cause fatigue, heart palpitations, pale skin, and breathlessness.

Their concentrations can be too low due to insufficient uptake or insufficient bioavailability. Bioavailability can be enhanced by specific promoters like ascorbate (vitamin C), β-carotene (pro-vitamin A), protein cysteine and various organic and amino acids (Table 2).

Ironically, the spread of micronutrient deficiency is related to the spread of high-yielding rice, wheat and maize varieties during the first phase of green revolution. These varieties are generally low in micronutrients, but also have displaced a variety of crops grown previously, such as pulses, vegetables and fruits which used to prevent a lack of micronutrients (Roozendaal 1996).

Table 1 Some of the essential functions of iron in plants, animals and humans
Source: Srivastava and Gupta (1996)

Elements	Plant	Animal and Human
Iron	i. Cytochromes and metalloenzymes. ii. Necessary in photosynthesis, iii. Involved in nitrogen metabolism as it is part of enzyme nitrogenase iv. Iron is also part of the enzyme leg-heamoglobin (role in nitrogen fixation) v. Prevents plants from severe physiological disorders like necrosis and chlorosis vi. Heme is essential component of cytochrome protein and thus mediates redox reactions	i. Fe is a constituent of hemoglobin and myoglobin which are essential components for storing and diffusing oxygen ii. Important for neurological functioning and development iii. Involved in redox reaction and thus responsible for cellular growth

In humans the uptake and absorption of iron is complex and depends on many factors. There are two forms of Fe in food: non-heme Fe and heme Fe. The heme Fe is mainly present in animal tissue, has a high bioavailability and is weakly influenced by other factors present in diets while the non-heme Fe comes from vegetables, legumes, fruits, and vegetables and its absorption depends on various dietary components (Abbaspour *et al.,* 2014) .

Table 2: Inhibitors and enhancers of iron bioavailability

Element	RDA	RNI	UL	SUL	Inhibitors	Enhancer
Fe (mg)	8.0-18.0	11.4	45.0	17.0	Phytate, tannins, oxalate, fiber, hemaglutinins	Phytoferritin, riboflavin, ascorbate, b-carotene, cysteine, histidine, lysine, fumarate, malate, citrate

Source: White & Broadley (2005). The US recommended daily allowances (RDA, or adequate intakes), the UK guidance daily reference nutrient intakes (RNI), the US tolerable upper intake levels (UL), and the UK guidance safe upper levels (SUL) for adults

IRON ASSIMILATION MECHANISMS IN PLANTS

Plants get their minerals from the soil. The process of micronutrient uptake, accumulation and their regulation is a dynamic process that should avoid deficiency or toxicity in the plant. This process is dependent on various factors like transporters within the plant, genotype of the plant and the environment (soil). To start a successful breeding program there is the necessity to understand physiological mechanisms of

micronutrient absorption, translocation, remobilization in leaves and re-translocation into seeds.

About 80% of the Fe is stored in chloroplasts and this accumulation is developmentally controlled. In roots some essential proteins and enzymes like leg-hemoglobin and nitrogenase are required for iron accumulation. Plants can also uptake elements in gaseous or ions forms through their stomata and cuticles. Cations like Fe^{2+} can be absorbed by the plants in gaseous forms with the help of ectodesmeta i.e. non-plasmic channels in the leaves (Prasad, 2007).

Iron, which is widely distributed in the lithosphere, is taken up by plants in two different ways: mechanism I (non-graminacious species) and mechanism II (cereals and grasses).

In mechanism I (reduction based), the Fe^{3+} present in the soil is chelated by phenolic compounds secreted by the roots; this reduces Fe^{3+} to Fe^{2+} with the enzyme, ferric reductase. Further, IRTs (iron regulated transporters) help in Fe^{2+} uptake and IRT1 is the major root plasma membrane transporter. Iron uptake is regulated by signals from the shoot when there is an iron deficiency. The nature of these signals is still unknown.

In mechanism II, Grasses, such as corn, wheat and rice, use the chelation based Strategy II. In response to Fe-deficiency, grasses release small molecular weight compounds known as the mugineic acid (MA) family of phytosiderophores (PS). PS have high affinity for Fe^{3+} and efficiently bind Fe^{3+} in the rhizosphere. Fe^{3+}–PS complexes are then transported into the plant roots via a specific transport system. The chelation strategy is more efficient than the reduction strategy and thus allows grasses to survive under more drastic Fe-deficiency conditions (Kim & Gueinot 2007)

Once iron is taken up by roots using active roots transporters, it is translocated via the xylem sap to aerial parts (Elizabeth and Jean, 2004). The flow of iron from source to acceptor tissues via phloem sap and the sub-cellular distribution is poorly understood and documented.

Seed is a store-house of food and nutrients and for obtaining high micronutrient levels it is important to understand the overall signaling networks involved in accumulation of these metals in the various organs and at different stages of development.

CONCLUSIONS AND FUTURE PERSPECTIVES

Although, very low amounts of micronutrients (Fe, Zn etc) are required in a diet, they all play a very important role in human physiology. Plant breeding in general focuses more on increasing yield and disease resistance. Now the time has come to improve micronutrient concentrations in crops. Developing cultivars with higher capacity to accumulate Fe and Zn will contribute significantly to the improvement of the micronutrient status of people.

In order to achieve this objective scientists have to first understand the genetics of high micronutrient traits and formulate a breeding strategy for improving micronutrient density in the edible parts of the crops.

Much of information has been obtained in recent years on Fe uptake components in plants. Of particular importance has been the cloning of FRO2, IRT1, and YS1 genes, enabling Fe uptake from the soil to be described at the molecular level. Characterization of additional members from these gene families will help in enriching our knowledge of Fe transport and distribution within the plant. The future challenge will be to elucidate the specific contribution of each family member by addressing their sub- cellular localization, tissue specificity, and gene regulation in response to Fe status.

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