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Milk Fever and Its Management In Bovines

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Milk fever is a disease of high yielding dairy cattle, most often seen in cattle 5 to 9 years old. A metabolic disease caused by a low blood calcium levels (hypocalcaemia). Characterized by Acute hypocalcaemia (serum Ca drops from normal-10mg% - >7mg% to below 5mg%). Associated with the onset of lactation and usually occurs within the first 72 hours following parturition. Cows in 3rd lactation or greater are more susceptible to the disease. Rapid synthesis of milk into udder, drains calcium from blood resulting in hypocalcemia. May see hypomagnesium (tetany) in conjunction with milk fever. Losses are due to deaths (about one in 20 affected cows dies), a reduction in the productive lifespan of each affected cow of about three years, and reduction in milk production following each milk fever episode, as well as costs of prevention and treatment.

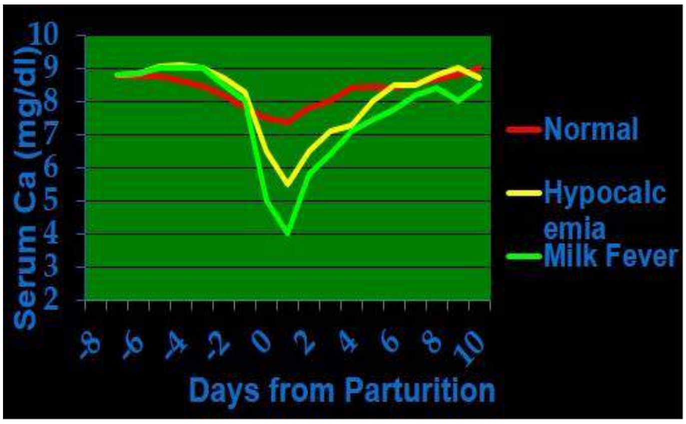

Fig. 1. Serum calcium levels under different conditions

CAUSES

In the time period shortly before calving, large amounts of calcium are removed from the blood and are utilized in the mammary gland to be part of the colostrum. Calcium in colostrum may be eight to ten times greater than in the blood supply. The rapid drop and the decreased mass of the calcium pool prior to parturition, and the failure of calcium absorption to increase fast enough after the onset of lactation, can predispose animals to milk fever or hypocalcemia.

Age is also important. Heifers are rarely affected. Old cows increase in susceptibility up to the fifth or six calving because they produce more milk and are less able to replace blood calcium quickly.

There are other probable causes that have been associated with inducing milk fever. They include excessive bone formation due to elevated levels of gonadal hormones and rations containing excessive dietary levels of cations, especially potassium. In addition, other metabolic disorders can lead to clinical and subclinical hypocalcemia (i.e. ruminal stasis, displaced abomasum, retained placenta, prolapsed uterus, metritis, and ketosis).

Signs and Symptoms

Milk fever is divided into three stages based on clinical signs:

Stage I milk (Excitation Stage) fever often goes unobserved because of its short duration (< 1 hour). Signs observed during this stage include loss of appetite, excitability, nervousness, hypersensitivity, weakness, weight shifting, and shuffling of the hind feet.

Stage II (Recumbency Stage) of milk fever can last from 1 to 12 hours. The affected animal may turn its head into its flank or may extend its head (flank watching). The animal appears dull and listless; she has cold ears and a dry nose; she exhibits incoordination when walking; and muscles trembling and quivering are evident. Other signs observed during stage II are an inactive digestive tract and constipation. A decrease in body temperature is common, usually ranging from 96°F to 100°F. The heart rate will be rapid exceeding 100 beats per minute.

Stage III (Coma Stage) milk fever is characterized by the animal's inability to stand and a progressive loss of consciousness leading to a coma. There is lateral recumbency and complete muscle flaccidity. Heart sounds become nearly inaudible and the heart rate increases to 120 beats per minute or more. Cows in stage III will not survive for more than a few hours without treatment.

BLOOD PARAMETERS

The most notable changes occurring in the blood are a decrease in blood calcium and blood phosphorus levels and an increase in blood magnesium levels. In cases of milk fever complicated by a lack of magnesium, the blood magnesium level may remain normal or even be depressed.

PREVENTION AND TREATMENT

Stage I

Stage II

Stage III

Management of the diet can be a valuable aid preventing milk fever. Cows should be kept on a low calcium diet while they are lactating (dry). This stimulates their calcium regulatory system to keep the blood levels normal by mobilising the body stores of calcium from the bone.

When the demand for calcium increases as calving, calcium can be mobilised much more rapidly from bone than the feed, therefore preventing milk fever.

- With cows at greater risk - Cows of mature age and in forward to fat condition - green feed should be restricted and plenty of hay fed for at least 1-2 weeks before calving. Neither should contain a high percentage of clover or capeweed.

Table 1: Illustrates the blood mineral levels for animals in various stages of milk fever.

State	Blood serum (mg/dl) Calcium	Blood serum (mg/dl) Phosphorus	Blood serum (mg/dl) Magnesium
Normal lactating cow	8.4 to 10.2	4.6 to 7.4	1.9 to 2.6
Normal a parturition	6.8 to 8.6	3.2 to 5.5	2.5 to 3.5
Milk fever, Stage I	4.9 to 7.5	1.0 to 3.8	2.5 to 3.9 a
Milk fever, Stage II	4.2 to 6.8	0.6 to 3.0	2.3 to 3.9 a
Milk fever, Stage III	3.5 to 5.7	0.6 to 2.6	2.5 to 4.1 a

Sources: Compiled from The Ruminant Animal: Digestive Physiology and Nutrition. Prentice Hall, Englewood, NJ. 1988. Chapter 24, Metabolic problems related to nutrition. pg. 494; The Dairy Reference Manual, Northeast Agricultural Engineering Service, Ithaca, NY. 1995. Chapter 6, pg. 167; and J. Dairy Sci. 71:3302-3309, 1988. a Milk fever complicated by low magnesium may result in serum magnesium ranging from 1.4 to 2.0 mg/dl.

- Limit grain intake to a maximum of about 0.5% to 0.8% of body weight. Limit legume or mixed mainly legume forage to 30% to 50% of forage dry matter intake. Limit corn silage to 50% of the forage dry matter intake.Remove moldy or spoiled forage or feed from the ration, especially those testing positive for mycotoxins.
- If it is necessary to improve the body condition of cows in order to improve milking performance, feeds high in energy but low in calcium may be used, for example cereal grain or oaten hay. Cereal grain is also high in phosphorus content, and this is of additional value.
- Cows close to calving should be kept in a handy paddock to enable frequent observation and early detection of milk fever. On the point of calving, and afterwards, the available feed and calcium should be unrestricted. Calcium feed supplements may be helpful at this point, but should not be given earlier.
- Where dietary management is inadequate, other methods are

sometimes used. Vitamin D3 given by injection 2-8 days before calving may be useful. As the calving date is often difficult to predict, repeated treatments are sometimes necessary.

- A common treatment used to prevent milk fever is the injection of calcium borogluconate just before or just after calving. Some cows are given more than one treatment. This is quite successful because the calcium provides a reservoir to increase blood calcium just at the time it is needed for milk and colostrum. The danger is that it may not last long enough and milk fever may still occur before the calcium-regulating mechanism of the cow is working efficiently.
- Drenching cows with Unimix on the day before and then twice daily for 1 to 2 days after calving has considerably reduced the incidence of milk fever in some herds where other methods alone have been unsatisfactory. Unimix is a registered product containing a mixture of calcium and magnesium.
- Cows that have required injections to treat milk fever will benefit from a drench of Unimix to help prevent relapses.
- Use plain calcium borogluconate for the first treatment to minimize refractory cases.
- Inject intramuscularly 10 million units of vitamin D3 in a water-soluble, highly crystalline form within 24 to 48 hours of expected freshening. *Do not repeat dose for at least 10 days if cow doesn't freshen*. Use three million units in a repeat dose.
- Before giving up on downer cows, give a drench of two pounds of Epsom salts in one gallon of water. This will sometimes remove toxins in the lower gastrointestinal tract and enable cows to stand within two to four hours.

DIETARY CATION — ANION BALANCE

Another method of preventing and controlling milk fever is balancing 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. Cows fed anionic diets ($CaCl_2$, aluminium sulfate, Mg sulfate) had no milk fever (also 7% more milk) and ~50% of those fed cationic diets (Na carbonate and bicarbonate) had milk fever .

Increased amount of anions in the blood leads to acidic condition in blood leading to increased production of parathyroid hormone, increased responsiveness to PTH, increased production of 1, 25(OH)2D3(increased intestinal absorption) and increased osteoclast resorption. If animals are fed with more dietary cations (K & Na) will leads to metabolic alkalosis which results in reduced responsiveness to PTH. In animals fed with acidifying diet buffering is done by mobilization of Ca phosphate from bones hence more absorption of calcium and less occurrence of milk fever.

Agricultural and Anthropogenic Activities Influence on Aquatic Ecosystem

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It is our necessity and present day need to maintain and improve fertility of farmland soils to meet nutritional requirement of crop plants. Increasing fertility of farmland soils by chemical fertilizers containing nitrogen and phosphorous is everywhere exercised in world. Farmers put tones of fertilizers every season in their own fields for growth of crop plants. Soil system become enriched with nitrogen, and further crop plants take only 60-70 % of dissolved form of nitrogen and phosphorous. Remaining portion get leached or washed away with rain into near water bodies (Kashyap et al. 2015b). Anthropogenic activities further aggravates intrusion of more and more nutrients. By this process nutrient enrichment occurs in nearby water bodies. Aquatic plants, especially algae or phyto-planktons take up already dissolved nutrients and flourish well in water bodies (Kashyap et al. 2016). They take shape of big "water blooms", cover entire surface of water body and prohibit passage of sunlight to plants community underneath water body. In this way, photosynthesis stops resulting in dying of plants and oxygen gets depleted making anoxic conditions for aquatic fauna. It further results in death of fishes and aquatic organisms.

CASE STUDY OF REWALSAR LAKE

Rewalsar Lake of district Mandi in Himachal Pradesh has a national importance and located 24 km away from city Mandi in Himachal Pradesh, India. It is a mid-altitude lake situated at 1,360 meters above mean sea level. The lake is shaped like a square with a shoreline of about 735 m and is surrounded by mountain spur and dense vegetation. It appears like a dark jewel nestling in between the mid hills of Indian Himalayas. Apart from the scenic beauty, the holy lake is also famous among the Hindu, Sikh and Buddhist pilgrims (Kashyap *et al.* 2015c). Ecological processes within catchments exert a strong control on the inputs of organic and inorganic chemicals, both particulate and dissolved, into the down slope streams. The disruption of inputs from the catchments is a reliable signal of disturbance. Natural disturbing forces on catchments include fire, cyclones, over grazing, and defoliation by insects etc., while human generated/induced disturbances consist of forces such as encroachment, conversion of forest to agricultural land, timber harvesting, livestock grazing and land clearing. It may be due to developmental projects or population pressure on the natural resources (Kashyap et al. 2015a).

In aquatic ecology of lake, the disturbance is most commonly conceived as being due to physicochemical, biological and anthropogenic factors. The alteration in the physicochemical characteristics of aquatic ecosystem is the result of inputs of pollutants from point and non-point sources. The non-point sources of pollution are very difficult to assess and manage. Remediation is also difficult because it usually requires measures to be implemented over a large scale.

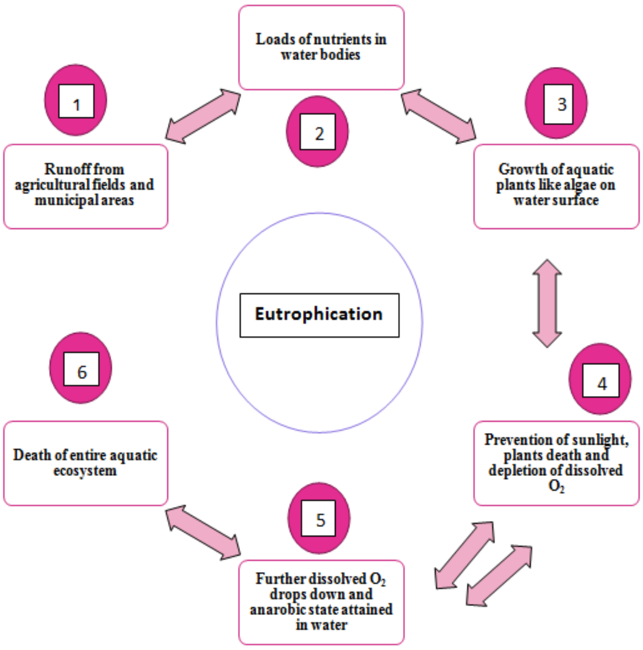

Figure 1: Representation of aquatic ecosystem failure due to excess of nutrient enrichment (eutrophication)

Discharge of pollutants from point and non-point source, deforestation, extensive cultivation, building construction, road construction and widening, setting of industries, discharge of untreated effluents, domestic sewage etc. not only pollute the water body but also cause increased silt flow into the lake basin making it shallow hence cutting short the life span of the lake.

Since the lake is multipurpose in use, the public attention is focused on water quality of the lake. Moreover there could be many reason of dying of fishes as pollution is rising to an alarming degree day by day in the lake. The poor sewerage system of Rewalsar town is further increasing the problem as contaminated water directly flows into the lake. Faith restrains one from eating these fish so the population has also gone up to an alarming level and congestion of fish population also attributed to the death of fishes. In addition to the natural heterogeneity in the physical characteristics of the catchment of lake, the distribution and disposition of different land uses may hugely influence catchment's response by modifying the connectivity and continuity of drainage lines.

Due to increased pollution pressure and sources of pollution (non-point sources) like agricultural runoff, soil erosion, diversion of water from catchment for irrigation, faulty agricultural practices, population densification, human induced pressure on land use, construction activities and bad practices of solid waste deposition around the lake reduced drastically its life span and creating threat to aquatic life (Kashyap *et al.* 2015c).

- ✓ Creation of buffer zones between Lake ecosystem and agricultural fields, so that sediments gets deposited in buffers instead of deposition in water.
- ✓ Treatment of waste discharged from industries.
- ✓ Recommended use of fertilizers.
- ✓ Adoption of integrated and organic farming in catchment areas.
- ✓ Testing of nitrogen and phosphorous in agricultural fields.
- ✓ Stop overgrazing and removal of grass cove.
- ✓ Improving efficiency of fertilizers.
- ✓ Minimizing non-point source pollution such as treatment of runoff water.
- ✓ Reduction in livestock densities.
- ✓ Oxygenation of water by physical methods for aquatic ecosystem revival.

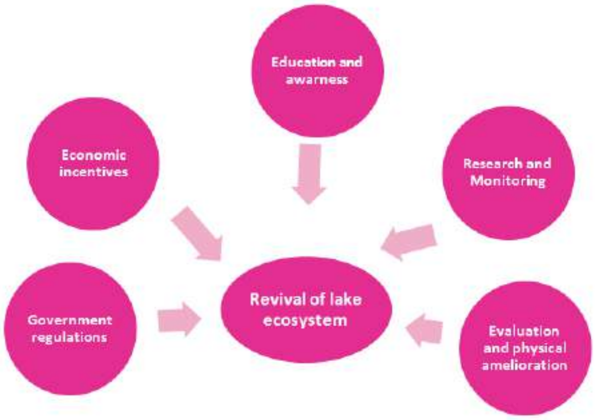

Figure 2: . Schematic conclusion

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Figure 3: Rewalsar Lake

Crop residues and management

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Agricultural or crop residue is biomass left in field after harvesting economic components such as grains. Crop residue includes non-edible plant parts that are left in the field after harvest. These residues involve cereal straws, woody stalks, and leaves/tops during harvest periods and are generated in large quantities every year. Processing of farm produce also produces large amount of residues. A large portion of the crop residues is not utilized and left in the fields. The disposal of such a large amount of crop residues is a major challenge. In most parts of the country, the crop residues are burned *in situ* to clear the field rapidly and inexpensively (Panwar *et al.* 2012). Farmers prefer burning as it is a quick and easy way to manage the large quantities of residues and prepare the field for the next crop well in time. Agriculture residue burning assumes a problem figure during October - November and April - May during harvesting of paddy and wheat. Unutilized crop waste and cropland fires are predominant in the North western part of the India especially in parts of Punjab, Haryana and Western Uttar Pradesh (Jain *et al.* 2014).

CROP RESIDUE GENERATION SCENARIO

Residue generated by different crops can be grouped in four categories based on the type of crop, namely cereals, oilseeds, fibers and sugarcane. Total amount dry crop residue generated by nine major crops is 620.4 Mt. Among various crops, cereals generate 361.85 Mt of residue was generated by cereal crops followed by fibre crops (122.4 Mt) and sugarcane (107.5 Mt) (Jain *et al.* 2014) There is a large variation in crop residues generation across different states of India depending on the crops grown in the states, their cropping intensity, and productivity. Generation of cereal crop residues is highest in the states of Uttar Pradesh followed by Punjab, West Bengal, Andhra Pradesh and Haryana. According to IPCC the 25% of the crop residues are burnt on farm. Fraction of crop residue subjected to burning ranged from 8–80% for rice paddies across the states. In the states of Punjab, Haryana and Himachal Pradesh 80% of rice straw was burnt *in situ* followed by Karnataka (50%) and Uttar Pradesh (25%), which can be attributed to the mechanized harvesting with combine harvesters (Kumar *et al.* 2015)

Among the different crop residue major contribution (93%) was from rice (43%), wheat (21%) and sugarcane (19%). Highest amount of cereal crop residues were burnt in Punjab followed Uttar Pradesh and Haryana. Uttar Pradesh contributed maximum to the burning of sugarcane trash followed by Karnataka (Jain *et al.* 2014).

CROP RESIDUE BURNING AND ENVIRONMENTAL HAZARD

Agricultural residues burning may emit significant quantity of air pollutants like CO_2, N_2O, CH_4 and other air pollutants such as CO, NH_3, NOx, SO_2, volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) and particulate matter (PM). One tonne of paddy straw burning releases 3 kg particulate matter, 60 kg CO, 1460 kg CO_2, 199 kg ash and 2 kg SO_2 which adversely affect public health. Particulates smaller than 10 microns (PM_{10}) easily enters into the lungs and cause acute respiratory problems. In addition to respiratory diseases the air pollutants released due to residue burning may also cause other severe health hazard such as eye, nose, throat and skin irritation, irritation in mucous membrane, bronchitis, asthma, lung and heart diseases. These pollutants by undergoing various chemical reactions in the atmosphere synthesize even more harmful secondary pollutants such as troposphere ozone, photochemical smog etc.

LOSS OF SOIL PRODUCTIVITY

Burning of crop residue not only leads to pollution but also results in loss of nutrients present in the residues. Continuous removal and burning of agricultural residues lead to net losses of nutrients under standard fertilization practices, which ultimately will lead to higher nutrient cost input in the short term and reduction in soil quality and productivity in the long term. Burning of crop residue results in substantial loss of nutrients present therein and adversely affect nutrient budget of soil. The entire amount of C, approximately 80–90% N, 25% of P, 20% of K and 50% of S present in crop residues are lost in the form of various gaseous and particulate matters, resulting in atmospheric pollution.

MANAGEMENT OF AGRICULTURAL RESIDUE USE IN AGRICULTURE

Waste agriculture residues serve multiples of benefits if managed properly. Rice and Wheat straw can be used as fodder, compost and mulch. Wheat straw is an excellent quality fodder and can be used for large scale hay and silage production. Crop residues can be converted into high-value manure of better quality than FYM, and its use, along with chemical fertilizers, can help sustain or even increase the agronomic yield. Conservation of soil and water resources is of paramount importance for sustaining cropland productivity. 50% of total evapo-transpiration from a crop can be lost through evaporation from the soil surface. Mulching is the only practice that reduces the evapo- transpiration by decreasing evaporation. Mulching also suppress the weed growth.

CROP RESIDUE AND SOIL PRODUCTIVITY

When all crop residues are burnt, this benefit is completely lost. As a result, sustaining soil productivity becomes more difficult. Returning crop residues soil quality through its impact on reducing risk of soil erosion, recycling nutrients, stabilizing soil structure and improving tilth, reducing soil bulk density, improving soil retention and transmission properties, providing energy for microbial processes, increasing cation exchange capacity and enhance agronomic productivity.

CROP RESIDUE -AS A SOURCE OF ENERGY

India generates a huge amount of agricultural waste every year and the ministry of new and renewable energy estimates this waste can generate more than 18000 MW of power every year apart from generating fertilizer for farmers. Instead of burning crop residues may be used for production of energy such as charcoal, alcohol, producer gas, biogas etc. Agriculture residues can be directly used in agro- based biomass plants as a source of bio power by conversion of biomass to electricity. One of the bio power options is direct combustion - the burning of straw alone (direct-firing) or in combination with coal (co-firing) to produce steam to drive a turbine that turns an electricity generator. Other bio power options are gasification – in which straw is heated in the presence of limited O_2 to form a gas mixture of N_2, H_2, CO, and CO_2 known as producer gas or synthesis gas, and pyrolysis - in which straw is heated excluding O_2 to form a high-energy liquid. Biomass densification represents a set of technologies for conversion of biomass into a fuel and briquetting is one of them. These industries can further apply for Clean Development Mechanism funding and generate funds through carbon trading (Panwar *et al.* 2012).

Agriculture residue can be used for biogas production by anaerobic fermentation using cattle dung as a source of inoculums, thus providing energy as methane, protecting the environment by reducing the pollutants and yielding good amount of spent solids, which can be used as manure in the field. Rice straw can be used as fuel for generating electricity. It can also be used as raw material in cardboard and paper industries. Power generation from agro waste is a lucrative option but still in crawling stage due to absence of proper channel for collection of the residues from the field. Agriculture residue can also be used as biofuel by conversion of biomass to liquid fuel such as ethanol (Naik et al. 2010).

CONCLUSION

In spite of imposed ban on burning of crop residue and other efforts to reduce this practice, not much success is obtained to stop this practice. Proper agriculture waste collection system should be designed to collect agriculture residue in short span of time and should be channelized for efficient management. In addition, Government should give subsidies to industries using agriculture residue and other products obtained from it as a fuel. The appropriate management of crop residue will not only generate monetary funds for farmers but will also help in improving the quality of environment achieving sustainable productivity and allow farmers to reduce nutrient and water inputs, and reduce risk due to climate change.

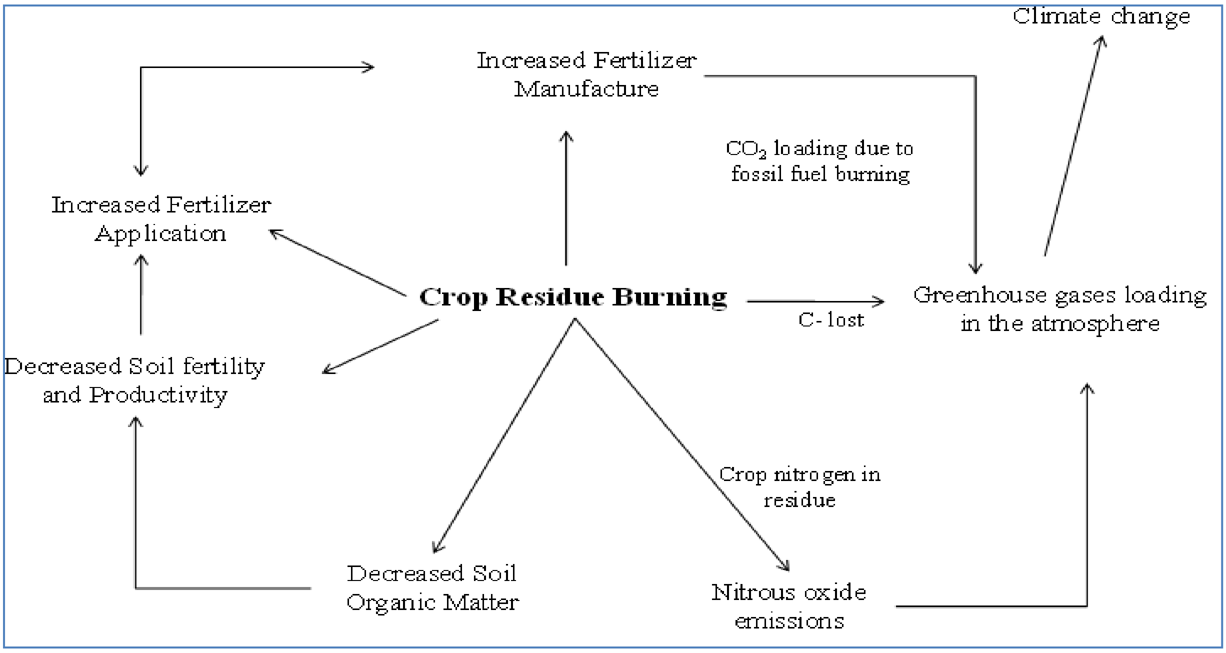

Figure1: Interactive effects of crop residue burning

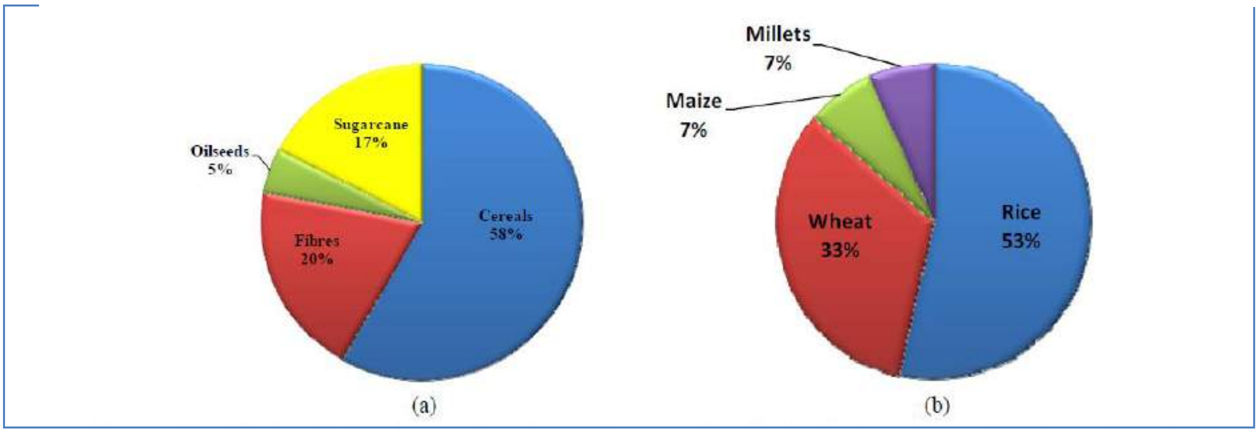

Figure 2: (a) Contribution of different crops categories in residue generation (b) Contribution of different cereal crops in residue generation (Source: Jain *et al.* 2014)

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Climate Smart Agriculture: R-W Cropping System

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South Asia, residence of about 1.5 billion people, over 30 per cent of whom are still living in poverty, facing a major challenge of achieving hasty economic growth to reduce poverty and attaining other Sustainable Development Goals under emerging challenges of natural resource degradation, energy crisis, unstable markets and risks associated with global climate change (Jat *et al.*, 2016 and Lal, 2016). During past half century (1965-2015), in process of achieving multi-fold increase in crop production in the region, inefficient use and inappropriate management of non-climate production resources (water, energy, agro-chemicals) have vastly impacted the quality of the natural resources and also contributed to climatic variability affecting farming adversely. The natural resources in South Asia especially in Indo-Gangetic plains (IGP) are 3-5 times more strained due to population, economic and political pressures compared to the rest of the world and can potentially add to adversity of climatic risks, making a large number of people in the region vulnerable to climate change. Increasing climatic variability affects most of the biological, physical and chemical processes that drive productivity of agricultural systems including livestock and fisheries (Easterling *et al.,* 2007).

SCENERIO OF R-W CROPPING SYSTEM

Rice-wheat (R-W) is the most important cropping system for the food security of South Asia, providing food for more than 400 million people (Ladha *et al.,* 2003). In India, the system contributes 26% of total cereal production and 60% of total calorie intake (Gupta *et al.,* 2003) and contributes about 40% of the country's total food basket (Gupta and Seth, 2007 and Sharma *et al*., 2015). The area under the R-W cropping system covers around 32% and 42% of total rice and wheat area, respectively (Saharawat *et al*., 2012). The productivity and sustainability of the
system are threatened because of the incompetence of current production practices, shortage of resources and socio-economic changes (Ladha *et al.,* 2003 and Chauhan *et al.,* 2012). Pressure is increasing on the limited land, water and environmental resources for

producing more food to match the demand of the escalating population. During past two decades, the R-W cropping system is showing the sign of exhaustion because of continuous use of traditional practices which resulted in to yield stagnation and declining factor productivity (Ladha *et al*., 2003 and Jat, *et al*., 2011). In addition, there has been enormous damage to available natural resources (soil, water and energy). The declining soil fertility (Jat *et al*., 2014), depletion of ground water (Singh *et al.,* 2014a), increasing shortage of labor and energy, rising problem of salinity and alkalinity (Bhattacharya *et al.,* 2015), multiple micronutrient deficiency, emergence of herbicide resistant and shift of weed flora besides environmental pollution through emission of greenhouse gases (GHGs) and large scale burning of rice straw are very complex and serious issues in RW belt of IGP (Samara *et al*., 2003 and Hobbs *et al*., 2008; Timsina and Connor 2001; Yadav *et al.,* 2016). These emerging challenges have put a big question mark on the sustainability of RW cropping system.

PRESENT FARMING PRACTICE AND CLIMATE CHANGE

The conventional farmers' practices of transplanting rice seedlings manually after repeated dry and wet tillage (Puddling) followed by conventionally tilled wheat seed broadcasting contributes significantly to the challenges described above and making R-W system unsustainable. Conventional practices are water, capital and energy intensive and deteriorating the soil health (Sharma *et al.,* 2003). Intensive puddling in rice increase in soil strength in surface and sub-surface layers due to illuviation of clay, iron and manganese compounds, decrease in hydraulic conductivity and infiltration leads to water stagnation, poor root development, and low recharge of aquifers (Gathala *et al.,* 2011b and Bhushan and Sharma, 1999). Economically, R-W cropping system is becoming less and less profitable because of the increasing input costs involved with the conventional tillage (CT) practices (Gathala *et al.,* 2014). Also the results of long term field trails in Indian IGP have shown declining trends in the productivity of RW system with 0.02 t/ha/year even after using the recommended dose of fertilizers (Duxbury *et al*., 2000). The use of blanket nutrient management recommendations in India has led to low nutrient use efficiencies, lowered profits and increased environmental problems (Pampolino *et al.,* 2012a). Nutrient recommendations in India are based upon crop response data averaged over large geographic areas and do not take into account the spatial variability in indigenous nutrient supplying capacity of soils (Sapkota *et al.,* 2014). Such unbalanced and inadequate use of nutrients can decrease the nutrient use efficiency and profitability and may increase environmental risks associated with loss of unutilized nutrient through emission or leaching. This further increases the agriculture's share to total GHGs emissions. High temperature during wheat maturity suppress the current photosynthesis, inhibits starch synthesis (Sharma *et al.,* 2015), shortens grain filling duration and rate of grain filling (Lobell *et al.,* 2012) and all leading to shriveled grain, poor grain quality and lower yields.

Pathak *et al.* (2003) reported a yield loss of 15-60 kg/ha/day if wheat planting is delayed beyond mid-November in N-W India.

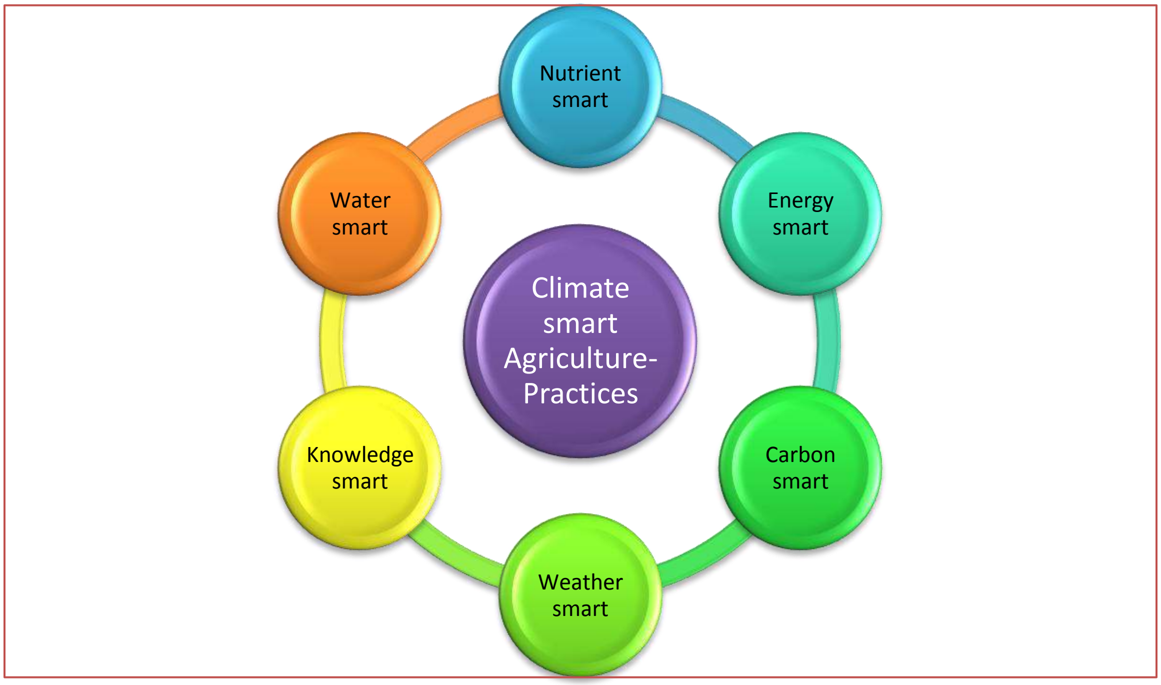
EFFECT OF CLIMATE CHANGE

The growth rate of the agriculture production is less as compared to human population in South Asia. With no scope for horizontal expansion of farming we need to produce 70% more food to feed the projected world population of 9.7 billion by 2050. Nonetheless, having high risks of climate change induced extreme weather events, the crop yields in the region are predicted to decrease from 10 to 40% by 2050 with risks of crop failure in several highly vulnerable areas. Increase in mean temperature, increased variability both in temperature and rainfall patterns, changes in water availability, shift in growing season, rising frequency of extreme events such as terminal heat, floods, storms, droughts, sea level rise, salinization.

Perturbations in ecosystems have already affected the livelihood of millions of people. Studies showed that there would be at least 10% increase in irrigation water demand in arid and semi-arid region of Asia with a 10◦C rise in temperature (Sivakumar and Stefanski, 2011). Thus, climate change induced demand increase of irrigation water, could further aggravated resource scarcity. Moreover, climate change on the one hand, can intensify the degradation process of natural resources which are central to meet the increased food demand, while on the other hand, changing land use pattern, natural resource degradation, urbanization and increasing pollution could affect the ecosystem in this region directly and also indirectly through their impacts on climatic variables (Lal, 2016). For example, about 51% of the Indo-Gangetic Plains may become unsuitable for wheat crop, a major food security crop for India, due to increased heat-stress by 2050 (Lobell *et al.,* 2012 and Ortiz *et al.,* 2008). Therefore, adaptation to climate change is no longer an option, but a compulsion to minimize the loss due to adverse impacts of climate change and reduce vulnerability (IPCC, 2014). Moreover, while maintaining a steady pace of development, the region would also need to reduce its environmental footprint from agriculture. Considering these multiple challenges, agricultural technologies that promote sustainable intensification and adapting to emerging climatic variability yet mitigating GHG emissions (climate smart agricultural practices) are scientific research and development priorities in the region (Dinesh *et al.,* 2015).

AGRICULTURAL PRACTICES TO COPE UP CLIMATE CHANGE- CLIMATE SMART AGRICULTURE

There are a wide range of agricultural practices that have the potential to increase adaptive capacity of production system, reduce GHGs emissions or to enhance soil carbon storage. The portfolios of climate smart agriculture (CSA), a set of smart management practices involving *water smart* (direct seeded rice, laser land leveling, tensiometer and weather forecast based irrigation), *nutrient smart* (site specific nutrient management through nutrient expert tools, green seeker, slow release nitrogen fertilizer and right placement of fertilizers), *carbon smart* (residue retention and incorporation), *weather smart* (index based crop insurance, weather forecast), *energy smart* (laser land leveling, direct seeded rice and zero tillage) and *knowledge smart* (Information and communication technology), are such innovative approaches that have demonstrated as the potential strategies to enhancement farm profitability, making crop production resilient to changing climate and to reduce ecological footprint of agricultural production system for sustainable food security.



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Rust Diseases of Wheat

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ABSTRACT

Three different rust diseases that affect wheat are leaf rust (also known as brown rust or orange rust), stripe rust (commonly known as yellow rust) and stem rust (commonly referred to as black stem rust). Rusts are notorious for their ability to spread rapidly and reduce wheat yield and quality. It all depends on the susceptibility of the variety, race of the pathogen present, timing of infection, and the weather conditions. Damage to wheat depends on the growth stage at the time of infection and the overall level of rust severity. High levels of disease before or during flowering usually have the greatest impact on yield. Rust causes losses by reducing the number of kernels per head and the size of the kernels, and by lowering test weight and the protein content of the grain. In the case of stem rust, additional losses may result from girdling of the stems which cause plants to lodge. However, for years, the widespread use of rust-resistant varieties has substantially reduced losses caused by leaf, stripe and stem rust.

INTRODUCTION

Rust diseases of wheat are among the oldest plant diseases known to humans. Early literature on wheat cultivation also mentioned these devastating diseases and their ability to destroy entire wheat crops. Since rust discovery, numerous studies have been conducted on the life cycles of rust pathogens and their management. The information gained from these studies has enabled us to develop best management practices that reduce the impact of the diseases. Today, worldwide epidemic losses are rare, though the diseases can occur at significant levels in particular fields or throughout a particular growing region. The persistence of rust as a significant disease in wheat can be attributed to specific characteristics of the rust fungi (Joshi *et al.,* 1986). These characteristics include a capacity to produce a large number of spores-which can be wind-disseminated over long distances and infect wheat under favorable environmental conditions-and the ability to change genetically, thereby producing new races with increased aggressiveness on resistant wheat cultivars.

Black or stem rust - *Puccinia graminis tritici*

Symptoms

Symptoms are produced on almost all aerial parts of the wheat plant but are most common on stem, leaf sheaths and upper and lower leaf surfaces. Uredial pustules (or sori) are oval to spindle shaped and dark reddish brown (rust) in color. They erupt through the epidermis of the host and are surrounded by tattered host tissue. The pustules are dusty in appearance due to vast number of spores produced. Spores are readily released when touched.

As the infection advances teliospores are produced in the same pustule. The color of the pustule changes from rust color to black as teliospore production progresses. If a large number of pustules are produced, stems become weakened and lodge. The pathogen attacks other host (barberry) to complete its life cycle. Symptoms are very different on this woody host. Other spores are Pycnia (spermagonia) produced on the upper leaf surface of barberry which appears as raised orange spots. Small amounts of honeydew that attracts insects are produced in this structure. Aecia, produced on the lower leaf surface, are yellow. They are bell-shaped and extend as far as 5 mm from the leaf surface (Fig. 1).

Brown or leaf rust - *Puccinia triticina (P. recondita)*

Symptom

The most common site for symptoms is on leaf blades, however, sheaths, glumes and awns may occasionally become infected and exhibit symptoms. Uredia are seen as small, circular orange blisters or pustules on the upper surface of leaves. Orange spores are easily dislodged and may cover clothing, hands or implements. When the infection is severe leaves dry out and die. Since inoculum is blown into a given area, symptoms are often seen on upper leaves first. As plants mature, the orange urediospores are replaced by black teliospores. Pustules containing these spores are black and shiny since the epidermis does not rupture. Yield loss often occurs as a result of infection by *Puccinia recondita* f. sp. *tritici.* Heavy infection which extends to the flag leaf results in a shorter period of grain fill and small kernels (Fig. 2).

Yellow or stripe rust - *Puccinia striiformis*

Symptom

Mainly occur on leaves than the leaf sheaths and stem. Bright yellow pustules (Uredia) appear on leaves at early stage of crop and pustules are arranged in linear rows as stripes. The stripes are yellow to orange yellow. The teliospores are also arranged in long stripes and are dull black in colour (Fig. 3, Rangaswami 1998).

Fig. 1. Stem rust

Fig. 2. Leaf rust

Fig. 3. Stripe rust

Pathogen

The uredospores of rust pathogen are almost round or oval in shape and bright orange in colour. The teliospores are bright orange to dark brown, two celled and flattened at the top. Sterile paraphyses are also present at the end of sorus.

Disease Cycle

In India, all these rusts appear in wheat growing belt during *rabi* crop season. Uredosori turn into teliosori as summer approaches. The inoculum survives in the form of uredospores / teliospores in the hills during off season on self sown crop or volunteer hosts, which provide an excellent source of inoculum. In India, role of alternate host (Barberis) is not there in completing the life cycle. The fungus is inhibited by temperatures over 20˚C although strains tolerant of high temperatures do exist. The complete cycle from infection to the production of new spores can take as little as 7 days during ideal conditions. The disease cycle may therefore be repeated many times in one season. During late summer, the dark teliospores may be produced. These can germinate to produce yet another spore type, the basidiospore, but no alternate host has been found (Smith 1972). Although teliospores seem to have no function in the disease cycle they may contribute to the development of new races through sexual recombination.

Management

Mixed cropping with suitable crops.
Avoid excess dose of nitrogenous fertilizers.
Spray Zineb at 2.5 kg/ha or Propioconazole @ 0.1 %.
Grow resistant varieties like PBW 343, PBW 550, PBW 17

CONCLUSION

Wheat is an important cereal crop which is greatly affected by the rust attack. The pathogen develops disease through uredospores, teliospores. The disease can be controlled by the use of resistant varieties of wheat.

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Artificial Insemination Technique for Commercial Poultry Production

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Assisted Reproduction Technologies (ART's), such as Artificial Insemination (AI) contribute to increase poultry production, as it allows a wider use of genetically superior cockerels with a high productive performance. The development of AI technique has allowed the rapid dissemination of genetic material from a small number of superior sires to a large number of females. The impacts of AI on genetic improvement and control of venereal diseases has been the greatest, due to the sharp increase in chicken meat consumption it has also become important to increase the production of layers to meet the demand. AI in poultry was first successful in 1899 when Ivanov produced fertile chicken eggs using semen recovered from the duct us deferens after killing a cock Chicken breeders may be disappointed when their better birds fail to reproduce. The birds may not mate because of shyness, physical limitations, and lack of interest or social incompatibility. Unsatisfactory nutrition, age of breeders, management conditions, egg collection and holding practices, and incubation procedures can also influence production. Purpose of artificial insemination in poultry is to place the required dose of semen into the oviduct of the female so that it is deposited near the sperm storage glands and to carry out the AI process with due regard to the best health and welfare of the breeder females thereby achieving the highest fertility levels possible.

Benefits of artificial insemination in the poultry are:-

- Normally one cockerel can mated to six to ten hens. With artificial insemination this ratio could be increased fourfold.
- Older males having outstanding performance can be used for several

generations. Whereas under natural mating their useful life is limited.

- Valuable male birds having the leg injury can still be used for artificial insemination.
- Elimination of preferential mating: When there is poor fertility caused by preferential mating, it can be eliminated.
- Although cross breeding is very successful under natural conditions, but sometimes there is a kind of colour discrimination as some hens will not mate with a male of a different colour unless they have been reared together. In such condition AI helps in successful cross breeding.

DIFFERENT WAYS OF SEMEN COLLECTION IN POULTRY

In 1937 Burrows and Quinn described a non-invasive method, the abdominal massage method for collection of semen from roosters. The technique involves restraining the male and gently stroking the back of the bird from behind the wings towards the tail with firm rapid strokes. The male responds with tumescence erection of the phallus, at which time the handler gently squeezes the cloaca extracting semen through the external papillae of the duct us deferens (vas deferens) collecting the semen into a container.

The techniques of AI actually begin prior to the procedure. It includes housing the male poultry away from the hens maximizes the amount of available semen. Because the bird's phallus is located in the same duct as his anus, removing food 12 hours prior to collection will help prevent fecal contamination of the semen. As with semen collection of other farm animals, one must stimulate the bird's sexual organ to extend outside of his body. One person can handle this procedure with small birds such as chickens.

EQUIPMENT REQUIRED FOR INSEMINATION

The equipment need not be lavish or expensive. It consists of a glass or plastic test tube for collecting semen from the male, a 3 cc hypodermic syringe with 0.1 ml graduations, a rubber connection (bicycle valve rubber), and a 0.5 cm external diameter glass inseminating tube 9 cm in length. Sometimes, a small plastic funnel is used where semen collection may be difficult. Equipment is illustrated below.

Artificial Insemination Equipment From top, clockwise: Syringe with inseminating tube and rubber Connection, Ringer's Solution, Glass Tube

In order to increase the number of hens that can be inseminated from the same rooster, the semen may be diluted with a solution known as modified Ringer's solution. The composition of this solution is as follows:

- Sodium chloride 68 grams
- Potassium chloride 17.33 grams
- Calcium chloride 6.4 2 grams

- Magnesium sulphate 2.50 grams
- Sodium bicarbonate 24.50 grams
- Distilled water 10 000 cc

Rather than go to the trouble and expense of preparing this solution, it can be purchased from some pharmaceutical companies. The degree to which semen can be diluted is in the ratio of one part semen to 2 parts diluent.

SEMEN COLLECTION

Collection involves restraining of male by holding, breast down, usually on a table or the knee of the collector, who is usually sitting. The bird is held by another operator or alternatively held in some type of mechanical leg clamp. The abdomen is then firmly massaged with one hand while the other hand is drawn across the back and over the tail feathers. The phallus will enlarge after 3–6 such massages depending upon variation between males, and at this time, the collector quickly places their hands around the cloaca. Cloaca is pressed from top and bottom using thumb and fore finger which allows the vent to evert out. The semen is then aspirated from the surface of the phallus directly into a sealed tube. At this time semen should appear on the end of the phallus. The procedure of manipulating the cloacal region can be conducted a second time to produce a second stream of semen. Semen is collected 4–6 times in a week.

Poultry AI technique

Generally there are two methods of semen deposition in poultry. These methods are the intra peritoneal insemination and vaginal insemination. The most reliable and successful routine for insemination of poultry, is by depositing semen directly in the mid vaginal area.

Intra peritoneal insemination

This technique of AI is not reliable and has been used periodically for many years. In this technique a sharp needle is punched through the abdominal wall and the cannula inserted to deposit semen in the region of the ovary.

Vaginal insemination

This is the most commonly used AI procedure and two personnel are required for this operation. The technique

Characteristics and Components	Cockerel
Ejaculate volume (ml)	0.2-0.5
Sperm concentration (×106/ml)	3000-7000
Sperm/ejaculate (×109)	0.06-3.5
Motile sperm (%)	60-80
Morphologically normal sperm (%)	85-90
Protein (g/100 ml)	2.8
pH	7.2-7.6
Fructose (mg/100ml)	4
Sorbitol (mg/100ml)	0-10
Inositol (mg/100ml)	16-20
Glycerylphosphoryl choline (GPC) (mg/100ml)	0-40
Ergothioneine (mg/100ml)	0-2
Sodium (mg/100ml)	352
Potassium (mg/100ml)	61
Calcium (mg/100ml)	10
Magnesium (mg/100ml)	14
Chloride (mg/100ml)	147

was developed in the 1930s and involves applying pressure to the hen's abdomen and everting (Turn inside out) the vaginal orifice through the cloaca. This procedure is also referred to as cracking, venting or everting the hen. Semen is deposited 2–4 cm into the vaginal orifice concurrently with the release of pressure on the hen's abdomen. Insemination is accomplished with sterile straws, syringes or plastic tubes. In large scale commercial operations, automated semen dispensers using individual straws loaded with a set AI dose are commonly used.

Semen collection and Insemination procedure

Figure 1. Semen collection from breeding rooster

Figure 2. Collected semen

Figure 3. Everting the cloaca

Figure 4. Vaginal insemination

- Only one straw must be used per hen. This should then be disposed of to prevent the spread of diseases between females

- For insemination, pressure is applied to the left side of the abdomen around the vent. This causes the cloaca to evert and the oviduct to protrude so that a syringe or plastic straw can be inserted into the oviduct and the appropriate amount of semen delivered.
- As the semen is expelled by the inseminator, pressure around the vent is released, which assists the hen in retaining sperm in the vagina or the oviduct.
- In chickens, due to the lower spermatozoon concentration and shorter duration of fertility, 0.05 mL of undiluted pooled semen, at intervals of 7 days, is required.

REGULARITY OF INSEMINATION

- Inseminations should be carried out on two consecutive days the first week and then once each week thereafter while fertile eggs are required.
- As poultry semen has a very limited life insemination of hens should be completed within one hour of semen collection.
- AI Should be done during afternoon
- During the morning, most hens have an egg in the oviduct, thus obstructing the free passage of semen to the ovary.
- Eggs are fertile after the second day of insemination and can remain fertile for two weeks or more.

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- If another male is to be used on the same hen in a breeding program, it is suggested that a period of three weeks elapse before the second male is used.
- Sample of the semen be examined under a microscope to check sperm motility if large number of males are to be used

CONCLUSION

Artificial insemination is a common practice in the poultry industry. The benefits of AI for broilers would include the following: the male: female ratio would be increased from 1:10 for natural mating to 1:25 with AI; with fewer males needed, there would be greater selection pressure on the male traits of economic importance and subsequently greater genetic advancement per generation. It may happen that sometime in the future, research addressing poultry sperm biology and the cellular and molecular basis of oviductal spermatozoa transport, selection, and storage will lead to the following innovations in poultry AI technology: insemination intervals increased to 10–14 days (versus 7-day) with fewer sperm per insemination; in vitro sperm storage for 24–36 h at ambient temperature with minimal loss of sperm viability; and, the possibility of transgenic progeny following the insemination of sperm carrying transgenes

Organic farming; a curative approach against pesticidal residue

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Organic agriculture was practiced for thousands of years without the use of hazardous chemicals. Artificial fertilizers were first created during the mid-19th century. These early fertilizers were cheap, powerful and easy to transport in bulk. Similar advances occurred in chemical pesticides in the 1940s, leading to the decade being referred to as the **'pesticide era'**. These new agricultural techniques, while beneficial in the short term, had serious longer term side effects such as soil compaction, erosion, and declines in overall soil fertility, along with health concerns about toxic chemicals entering the food supply. In the late 1800s and early 1900s, soil biology scientists began to seek ways to remedy these side effects while still maintaining higher production.

Pesticides-

Substances intended for preventing, destroying, attracting, repelling or controlling any pest including unwanted species of plants or animals during the production, storage, transport, distribution and processing of food, agricultural commodities, or animal feeds or which may be administered to animals for the control of ecto-parasites.

Major chemical groups of pesticides-

- **Organochlorines- S**uch as DDT (Dichloro dipenyle trichloroethane), HCH (Hexachloro cyclohexane), aldrin, dieldrin, endrin, heptachlor, toxaphene, chlorobenzilate.
- **Organophosphorus-** Such as Acephate, chlorpyriphos, dichlorvos, dimethoate, malathion, parathion, monochrotophos, triazophos, quinalphos.
- **Carbamates-** Such as Carbaryl, carbofuran, aldicarb, propoxur.
- **Synthetic pyrethroids-** such as Allethrin, cypermethrin, deltamethrin, fenvalerate, fluvalinate.
- **Neonicotinoids-** such as Imididacloprid, acetamiprid, thiamethoxam.
- **Phenyl-pyrazoles-** such as Fipronil.

Major categories of pesticides

- **Insecticides-** It includes pyrethroids, carbamates, organophosphorus, organochlorine and manganese compounds.
- **Rodenticides-** It includes warfarins, indanodiones.
- **Fungicides-** It includes thiocarbamates, dithiocarbamates, cupric salts, tiabendazole, triazoles,

dicarboximides, dinitrophenoles and organotin compounds.

- **Herbicides-** It includes bipyridyls, chlorophenoxy, glyphosate, acetanilides, and triazines.
- **Fumigants-** It includes aluminium and zinc phosphides, methyl bromides and ethylene dibromide.

Table No 1: Pesticidal contamination of food commodities

Scenario	% Contaminated	% Above MRL
World	21	2
India	60	14

(Agnihotri, 1999)

Thus, we can assume the catastrophic effects of pesticide residue in feed and edible items. Infect bio-magnification of pesticide residue is the burning issue of current scenario and we needs urgent action against ill effects of pesticide residue.

Health consequences of pesticide residue: Indiscriminate uses of pesticide causes hazardous ill-effects on health and well-being of society such as,

Integrated pest management (IPM):

It involves the use of cultural practices, crop husbandry, resistant varieties, biological and chemical control strategies; Scientist develops the strategies and farmers follows the prescribed practices. However, introduction of chemicals is frequently allowed as a significant step for the enhancement of production.

Non-pesticide management:

Emphasis on existing uses of hazardous chemicals towards safer biological and physical methods such as, through deep summer ploughing, bonefires and pheromone trapping.

Community managed sustainable agriculture:

Trade name	Possible health consequences
Camphechlor	Cancer causing, residual effects, toxic to fish culture
Chlordane/Heptachlor	Leukemia causing, toxic to wild life and long term residual effects
Chlordimeform	Cancer causing, bladder toxicity and ill-effects on wild life
DBCP (dibromochloropropane)	Cancer causing, sterility and residual conconcentration in water
DDT	Cancer causing, damage liver, nerves and brain, highly residual effects and toxic to wild life
Aldrin/ Dieldrin/ Endrin	Cancerous, teratological effects and residual effects
EDB (Ethylene Dibromide)	Potent cancerous, teratogenic and ill-effects on liver, lung
BHC/ Lindane	Cancer, miscarriage, leukemia and residual effects
Paraquat	No antidote is available and causing lung scarring
Endosulphan	Damage nervous system
PCP (Pentachlorophenol)	Nervous damage, liver damage and skin diseases
2, 4, 5 T (2,4,5-Trichlorophenoxyacetic acid)	Cancerous, teratogenic and residual effects

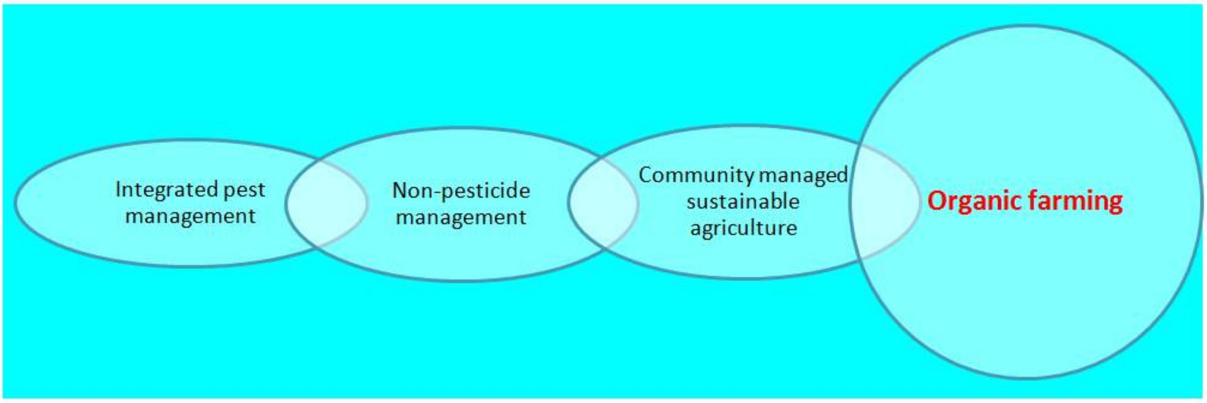
Focus on maintaining soil fertility and prevent pest incidence with minimum external inputs and judicious crop management. Farmers are connective link between technology development and extension. Farmers carry out diagnosis and replace chemical pesticides with physical and biological methods or bio-pesticides. Soil fertility is maintained by using bio-fertilizers or organic manure

Organic farming-

It is a method of crop and livestock production that involves much more than choosing not to use pesticides, fertilizers, genetically modified organisms, antibiotics and growth hormones. Organic production is a holistic system designed to optimize the productivity and fitness of diverse communities within the agro-ecosystem, including soil organisms, plants, livestock and people. The principal goal of organic production is to develop enterprises that are sustainable and harmonious with the environment.

Milestones of organic farming-

There are four important pillars of



organic farming

- **Principle of well-being -** Organic farming should sustain and enhance the health of soil, plant, human and plants as one and indivisible.
- **Principle of nature -** Organic agriculture should be based on living ecological systems and cycles, work with them, emulsion them and help sustain them.
- **Principle of justifications -** Organic agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities.
- **Principle of safety -** Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well being of current and future generations and environment.

General health considerations of organic farming-

- Protect the environment, minimize soil degradation and erosion, decrease pollution, optimize biological productivity and promote a sound state of health.
- Maintain long-term soil fertility by optimizing conditions for biological activity within the soil.
- Maintain biological diversity within the system.
- Recycle materials and resources to the greatest extent possible within the enterprise.
- Provide attentive care that promotes the health and meets the behavioural needs of livestock.
- Prepare organic products, emphasizing careful processing and handling methods in order to maintain the organic integrity and vital qualities of the products at all stages of production.
- Rely on renewable resources in locally organized agricultural systems.

SUMMARY

Organic farming can be a viable alternative production method for sustainability, but there are many challenges. One key to success is being open to alternative organic approaches to solving production problems. Determine the cause of the problem, and assess strategies to avoid or reduce the long term problem rather than a short term fix for it.

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Moderen Era Agriculture To Improve Productivity By Regenerative Agriculture

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Soil is the main key which decide the fruitfulness of the crop that is the crop will grow and yield more or not. A practice which deals with how we can keep our soil nurtured and fulfilled with minerals and to enhance the quality of the crop and farm is called Regenerative agriculture. Regenerative Agriculture improves the soil quality so that it will boost the yield and the fertility of the soil by adopting various factors. It is a kind of adoption of the factors and techniques to the agriculture field which works only on the profitability of the farm. This will strengthens and improve the growth for the present as well as for the future, various factors by which we can do regenerative agriculture are as follows:

A. **Holistic management:** This management technique deals with the decision which was made by farmer or the scientific person which make the holistic management approach on the basis of ecology which includes social status, biological and environmental aspect along with the financial status of the farmer. The scientists are working on the technique for more uses for farmers. The new framework was also prepared for regenerative agriculture to make it broad and useable for the farming community. Education does not lead to produce beneficial to farmer, but also need a practical platform where we need to prepare the techniques according to the problem of the farmers to uplift them. This approach is new but can be a game changer for he farmer if adopted judiciously according to available resources.

B. **Polyculture:** Growing of different kinds of crops on the same piece of land is called Polyculture. As every crop has their own demands for space, environment and nutrient, hence we need to focus on balancing the geometry of the land for different kinds of crop of a symbiotic nature which gives additional benefit to the farmer not the antagonistic crops which leads the farmer to think over his wrong decision. Growing one crop and same cropping system leads the soil to deterioration and to stop the monoculture and to enhance the quality of soil and status of farmer we need to add the variety of different crops to farm.

C. **Biological status of soil- the soil food web:** With the advancement of technology, nature is deteriorating in the race of mechanization. Defination of The Soil Food Web is basically the natural process which was accomplished by the microorganisms present in the soil such as bacteria, fungi, and other beneficial microbes, etc. They help the soil to improve its physico-chemical properties along with the biological status for making root rhizosphere healthy for the plant. The soil, which was full of beneficial microbes was very good for the growing crop which was directly or indirectly leads to profitability of farmer by high crop yield and reduced cost of cultivation by less use of chemical fertilizer uses, insecticides and pesticides.

D. **Managed Livestock:** The other way is to manage the livestocks which is the primary asset of the farmer, therefore their health and growth is important as this will affect the agriculture performance indirectly. The decision to invest in livestock need to think before knowing about the consequences and consideration in the mind. More managed the livestock more managed the farm and the business of the livestock will show colorful results. Proper management of livestock must be watched as grazing or fodder point of view. Number of cattle must be according to availability of fodder and other monetary issues so that the farmer gets benefit not the loss.

E. **Zero or No-till crop production:** Tillage of the soil means the damaging of soil. Tillage is actually the disturbance of the soil while preparing the field which is too dangerous for the soil microbes available underneath the land. Hence, we need to aware the farming community to do zero till or minimum so that it will not affect the soil health. The zero or no till production of crop leads to fertile soil, which ultimately produce good crops and hence be more profitable.

F. **Perennial crops:** Perennial crop is those from which by sowing of one time we get crop year after year like horticulture crops: apples and alfalfa, etc. Yes! These are the example of perennial crop which can be harvested repeatedly till they vanished. The practice to add to the field along with the crop you are cultivating is new and modern to agriculture. It increases the fertility of soil by reducing the erosion also reduces the soil erosion while balancing the habitat of the soil food web.

G. **Permaculture:** Permaculture is the another concept of regenerative agriculture. Permaculture is the method where we propose a landscape after knowing the availability of environment and agriculture. Harmony with nature is prime importance in permaculture. It has three main and primary standards: The Earth's Care, the People's Care and a profit on Investment or Surplus. Permaculture works on the important need of the farm as an additional activity. More efforts we made, great results will emerge.

H. **Thermal composting:** Thermal technique is one of the important composting methods among different techniques of composting. In this technique we maintain the soil microbes and population, which is good for plant growth. Thermal

Composting gives the best method to keep soil nutrients proficient and advantageous. The microorganisms are considerable of the fecundity of the soil. We need not to be surprised that soil organisms is very important for soil fertility and health.

Collective Wisdom- The Key to Integrated Agricultural Development

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India is mainly an agricultural country. Agriculture is the most important occupation for most of the Indian families. Economic Growth: Agriculture is the backbone of Indian economy. Though, with the growth of other sectors, the overall share of agriculture on GDP of the country has decreased. To achieve the sustain growth rate integrated farming system should be developed. At present, the farmers concentrate mainly on crop production which is subjected to a high degree of uncertainty in income and employment to the farmers. In this contest, it is imperative to evolve suitable strategy for augmenting the income of a farm. Integration of various agricultural enterprises *viz.*, cropping, fishery, animal husbandry, forestry etc. have great potentialities in the agricultural economy. These enterprises not only supplement the income of the farmers but also help in increasing the family labour employment.

1. The integrated farming system approach introduces a change in the farming techniques for maximum production in the cropping pattern and takes care of optimal utilization of resources.
2. The farm wastes are better recycled for productive purposes in the integrated system.
3. A judicious mix of agricultural enterprises like dairy, poultry, piggery, fishery, sericulture etc. suited to the given agro-climatic conditions and socio-economic status of the farmers would bring prosperity in the farming.

The "Green Revolution" technologies are often associated with environmental harm. Such damage is caused by the excessive use of mineral fertilizers and chemical pesticides as well as enhanced vulnerability to pests and diseases as a result of genetic homogeneity in the high yielding hybrid crop varieties cultivated over large contiguous areas. With increasing population there is a steady decline in the per capita availability of land and water. This makes higher productivity per unit of land and water imperative. Because of the environmental problems linked with traditional Green revolution technologies, higher productivity per unit of land and water must come from somewhat different production pathways. We have to produce more, but will have to do it differently. Inadequate purchasing power of large sections of people is due to lack of productive employment, modern industry is often not labour intensive and new jobs have to be found in the farm and non-farm sectors in rural areas. Productivity employment is an economic necessity because under conditions of smallholdings, income of family can be enhanced only through greater marketable surplus and multiple sources of income. Productivity improvement is also an ecological necessity since otherwise the remaining forests may be cleared for crop cultivation.

COMPONENTS OF INTEGRATED FARMING SYSTEM

1. Crops, livestock, birds and trees are the major components of any Integrated Farming System.
2. Crop may have subsystem like monocrop, mixed/intercrop, multi-tier crops of cereals, legumes (pulses), oilseeds, forage etc.
3. Livestock components may be milch cow, goat, sheep, poultry, bees.
4. Tree components may include timer, fuel, fodder and fruit trees.

GOALS OF INTEGRATED FARMING SYSTEM

- Maximization of farmers' income of all component enterprises.
- Rejuvenation / amelioration of system's productivity and achieve agro-ecological equilibrium.
- Minimize attack insect-pests, diseases and weed population through natural cropping system management.
- Reduce the use of chemicals fertilizers and pesticides to provide eco friendly environment.

ADVANTAGES OF INTEGRATED FARMING SYSTEM

- Increased productivity through increased economic yield per unit area per time by virtue of intensification of crop and allied enterprises.
- Improved profitability achieved mainly by way of reduced costs due to recycling of wastes of one enterprise as energy inputs for other systems.
- Greater sustainability in production on farm due to integration of diverse enterprises of different economic importance.
- Integration of different production systems provides an opportunity to solve malnutrition problem due to production of variety of food products.
- It is helpful in crop failure.
- Due to interaction of enterprises with crops, eggs, milk, mushroom, honey, cocoons silkworm Provides flow of money to the farmer round the year.
- Cash available round the year because of the linkage of dairy/mushrooms/sericulture fruit crops/vegetable crops/flower cultivation etc.
- Combing crop with livestock enterprises would increase the labour requirement significantly and would help in reducing the problems of under employment to a great extent IFS provide enough scope to employ family labour round the year.
- Fodder/pasture/tree species included in the system help to get more fodder and thus solve fodder crises to some extent.
- Inclusion of timber component in the farming system reduces pressure on forests.

- Diverse components integrated can provide enough scope to employment farm labour round the year.
- Slowing down migration processes and increasing social benefits through jobs and income generation.
- Helps to improve knowledge level therefore improve literacy level.
- It provides opportunity for the growth of agri-allied industries.
- There is also advantage of increased highest input use efficiency.
- Improved standard of living of the farmer because of the products like edible mushroom, fruits, eggs, milk, honey, vegetables etc.
- More efficient control of insects, diseases and weeds, leading to lower pesticide use.

COMPONENTS IN IFS

Agriculture + Fish farming
Agriculture + Horiculture
Agriculture + Pigeon rearing
Apiary + Mushroom cultivation
Sericulture + Azolla farming
Dairy +Kitchen gardening
Poultry + Fodder production
Goat rearing + Nursery
Piggery + Vermiculture
Forestry+ Livestock
Agriculture+ Bio gas

Integrated Farming System enables the agricultural production system sustainable, profitable and productive. It has multiple objectives of sustainability, food security, farmer security, poverty reduction, employment generation, secured income. Integrated farming practiced for maximising production through optimal use of local resources, effective recycling of farm waste for productive purposes, organic farming, and developing a judicious mix of income-generating activities such as dairy, poultry, fishery, goat-rearing, vermicomposted and others. It has about 95 % of nutritional requirement of the system is self sustained through resource recycling. As the numbers of enterprises are increased, the profit margin increases but simultaneously coupled with increase in cost of production and employment generation though the profit increase was marginal. This system is ecologically sound, economically viable, socially accepted and builds farmer capacities for adoption of productive, remunerative, eco-friendly and self-sustaining integrated farming systems.

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Soil Health Card:

One Step to Sustainability

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The Soil Health Card Scheme was launched by the Narendra Modi government in February 2015. Under this scheme, the government policy is to issue the soil health card to farmers for helping them get a good return by studying the superiority of the soil. According to the policy, the soil cards have to be issued to 14 crores farmers stretched to all over India. The soil health card is a printed report which will be given to the farmers once in a three years for his land holding.

WHAT IS A SOIL HEALTH CARD?

The soil health card is a printed report which gives the detailed assessment of all the physical, chemical and biological analysis of the soil. It will also provide the remedy or corrective measures need to be taken by the farmers according to the report of soil health to get high produce.

HOW THE FARMERS GET BENEFITS?

The farmers having cards will get the complete and well monitored analysis report of the soil for the specific crop which he will sow for that cropping season or system. The monitoring of soil will be done on a regular basis. The experts will guide the farmers for the specific solutions to improve the quality and excellence of the soil. To get the long term effect farmers need to do regular check up of soil and its health. Soil management practices like zero- tillage, crop residue management, less tillage practices,*etc*. These are some resource conservation technologies by adopting these we can improve our field's soil health.

This card can become more helpful and effective when filled out regularly by the same person over a period of time. The main aphorism is to find the different types of the soil's capacity to improve its fertility by adopting various methods to higher crop production in spite of the limitations of the soil health. Farmers get an idea of the soil health card on the recommendations of the fertilizer and nutrients, according to the crop and the type of soil. So, to get the maximum potential yield of the crop.

THE PROCESS OF CHECKING SOIL HEALTH?

In the country various soil testing labs will carry the testing of the soils which was done by the soil chemists or the experts or KVKs. The results will show the strength and weakness of the soil and the available nutrients in which range it is available in the soil. The experts also give suggestions and corrective measures to the farmer after analyzing the report. The experts also recommend various methods to improve the soil health and its quality. These results and recommendation are displayed in the soil health cards.

How far is the scheme successful?

In the first phase target of the scheme after launching in February, 2015 it is to distribute the cards in 84 lakh farmers, but till July, 2015 it was only issued to 34 lakh farmers. This is a flagship for the programme in the agricultural sector of the country. Among all the states in India, Andhra Pradesh is the one which has taken the lead in the allocation of the Soil Health Cards to farmers. Tamil Nadu and Punjab, the two other states have collected the maximum amount of soil samples for testing during the *kharif* season. Though, Tamil Nadu has not distributed the cards yet. Other states which are taking the lead in distribution and allocation of soil cards are Uttar Pradesh, Punjab, Chhattisgarh, Telangana and Odisha. Farmers in states like Haryana, Kerala, Mizoram, Arunachal Pradesh, Sikkim, Tamil Nadu, Goa, Gujarat, Uttarakhand and West Bengal have not been issued or a very less number of cards issued as against the targets set for them for 2015-16.

Launching of web portal for the soil health card

In order to make the Soil health card scheme more flourishing, the Government of India, along with the Department of agriculture , has also launched a soil health card agriculture portal. Two more agri-portals have been recently launched named as – Fertiliser Quality Control System and Participatory Guarantee System portal.

WHAT IS THE SOIL HEALTH CARD PORTAL?

The farmers necessitate to register at the web portal www.soilhealth.dac.gov.in along with the details of the soil-lab test reports and the soil sample report. The registered farmer can keep eye, *i.e.* track by following in the portal:

SOIL SAMPLES REGISTRATION:

Soil Health Card generation
Test Results by Soil Testing Labs
Fertilizer and Nutrients Recommendations
MIS module for monitoring progress

Main objective of the web portal is to assemble all the soil data and its health related issues in a single database which can further be used in research and development programme in future for the farmers and soil experts.The fundamental objective after the launch of the web portal is to create a single national database on the soil health which can be used in the future for research and planning for both by the farmers and the soil experts. The portal is available in English language but possible in near future it will come in the regional languages to help the farmer community.

Drought and heat stress: a Constraints in Potential Crop Production and their Management

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ABSTRACT

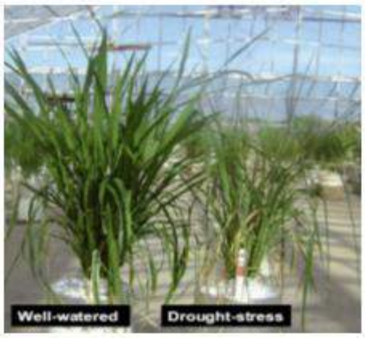
In the era of climate change, Drought and heat stress are the most important environmental stress severely impairs plant growth and development, limits plant production and the performance of crop plants. According to world estimates, an average of 40% and 17% yield losses in agricultural crops are caused by high temperature and drought respectively (Ashraf, 2008). Drought caused impaired mitosis, cell elongation and expansion; it disrupts photosynthetic pigments and reduces the gas exchange resulted in reduced growth and yield traits probably by disrupting leaf gas exchange properties. Heat stress increased the degree of water stress and the combined effects of drought and high temperature were much more severe than those of each individual effect. Heat stress and drought at post- anthesis shortened duration of maturation, grain filling duration and reduced grain yield, mean grain weight, grain number and thousand-grain weight (Kaur and Behl, 2010). The knowledge of heat stress and drought are important in understanding the mechanisms that regulate form, function and their agro-technique management.

INTRODUCTION

In today's climate change scenarios', crops are exposed more frequently to episodes of drought and elevated temperature. These stresses limit crop production. According to world estimates (Wang *et al*., 2007), an average of 50% yield losses in agricultural crops are caused by abiotic factors. These comprise mostly of high temperature (40%), salinity (20%), drought (17%), low temperature (15%) and other forms of stresses (Ashraf, 2008). Only 9% of the world area is conducive for crop production, while 91% is afflicted by various stresses. **In India also 67% of the area is rain fed and crops in these areas invariably experience droughts of different magnitudes.** Being a tropical country, India is more challenged with multitude of Drought and heat stress. The country has been experiencing losses in productivity due to episodic and frequent droughts, floods, degradation of land and extremes of temperature. These problems are likely to aggravate with changing climate putting forth a major challenge to attain food security in the 21st century. Thus, the main task ahead is to maintain the efficiency of agro-ecosystems on long term basis. Thereby, understanding drought and heat stress effect and responses in plants and enhancing stress resilience are the most demanding areas in agricultural research.

Impaired mitosis, cell elongation and expansion result in reduced plant height, leaf area and crop growth under drought.

Fig1. Effect of drought stress on the vegetative growth of rice cv. IR64



Drought:

Drought is a meteorological term and is commonly defined as a period without significant rainfall. Generally drought stress occurs when the available water in the soil is reduced and atmospheric conditions cause continuous loss of water by transpiration or evaporation. Three main mechanisms reduce crop yield by soil water deficit: (i) reduced canopy absorption of photo-synthetically active radiation, (ii) decreased radiation-use efficiency and (iii) reduced harvest index (Earl and Davis, 2003). Currently, there are economically viable Agro-technique means to facilitate crop production under drought. However, development of crop plants tolerant to drought stress might be a promising approach, which helps in meeting the food demands.

Effects of drought on plants

The effects of drought range from morphological to molecular levels and are evident at all phonological stages of plant growth at whatever stage the water deficit takes place. An account of various drought stress effects and their extent is elaborated below.

1. Crop growth and yield

The first and foremost effect of drought is impaired germination and poor stand establishment. Cell growth is one of the most drought-sensitive physiological processes due to the reduction in turgor pressure. Under severe water deficiency, cell elongation of higher plants can be inhibited by interruption of water flow from the xylem to the surrounding elongating cells (Farooq *et al.*, 2009).

2. **Water relations**

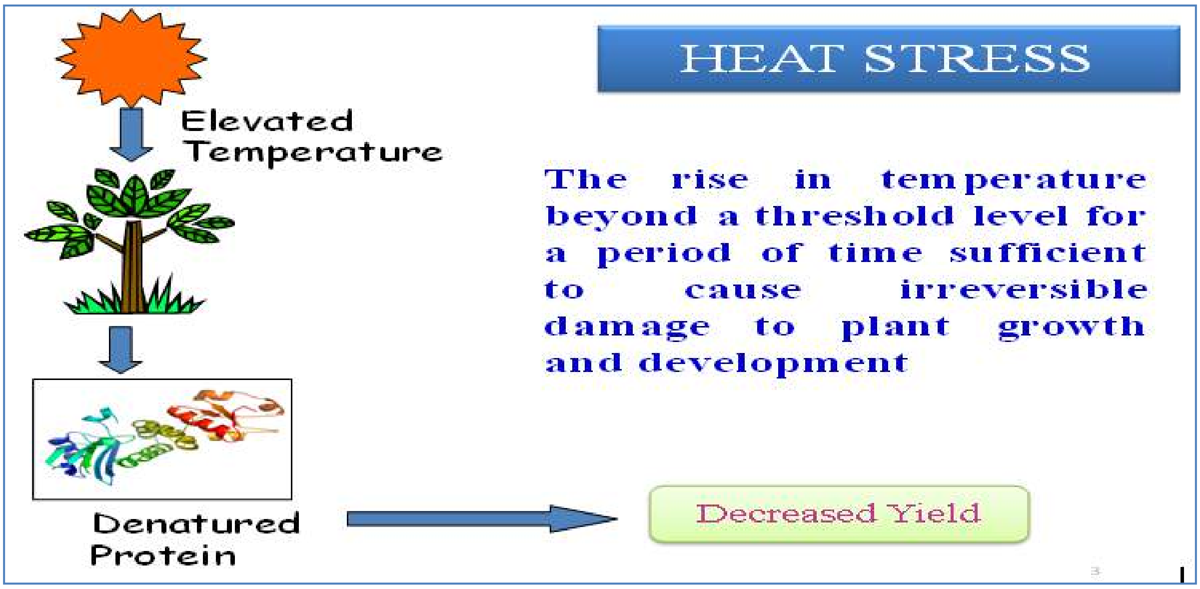
Relative water content, leaf water potential, stomatal resistance, rate of transpiration, leaf temperature and canopy temperature are important characteristics that influence plant water relations. Exposure of plants to drought stress substantially decreased the leaf water potential, relative water content and transpiration rate, with a concomitant increase in leaf temperature (Siddique *et al.*, 2001).

3. **Nutrient relations**

Decreasing water availability under drought generally results in limited total nutrient uptake and their diminished tissue concentrations in crop plants. An important effect of water deficit is on the acquisition of nutrients by the root and their transport to shoots. Lowered absorption of the inorganic nutrients can result from interference in nutrient uptake and the unloading mechanism, and reduced transpiration flow.

4. Reduced Photosynthesis

A major effect of drought is reduction in photosynthesis, which arises by a decrease in leaf expansion, impaired photosynthetic machinery, premature leaf



senescence and associated reduction in food production (Wahid and Rasul, 2005). When stomatal and non-stomatal limitations to photosynthesis are compared, the former can be quite small. This implies that other processes besides CO_2 uptake are being damaged. The role of drought-induced stomatal closure, which limits CO_2 uptake by leaves, is very important. In such events, restricted CO_2 availability could possibly lead to increased susceptibility to photo-damage (Cornic and Massacci, 1996).

5. **Respiration**

Drought tolerance is a cost-intensive phenomenon, as a considerable quantity of energy is spent to cope with it. A negative carbon balance can occur as a result of diminished photosynthetic capacity during drought, unless simultaneous and proportionate reductions in growth and carbon consumption take place. Water deficit in the rhizosphere leads to an increased rate of root respiration, leading to an imbalance in the utilization of carbon resources, reduced production of adenosine tri-phosphate and enhanced generation of reactive oxygen species.

6. **Oxidative damage**

Exposure of plants to certain environmental stresses quite often leads to the generation of reactive oxygen species, including superoxide anion radicals (O_2^-), hydroxyl radicals (OH^-), hydrogen peroxide (H_2O_2), alkoxy radicals (RO) and singlet oxygen (O_2) (Munné-Bosch and Penuelas, 2003). Reactive oxygen species may react with proteins, lipids and deoxyribonucleic acid, causing oxidative damage and impairing the normal functions of cells (Foyer and Fletcher, 2001).

High temperature or heat stress:

Heat stress is defined as the rise in temperature beyond a threshold level for a period of time that they cause irreversible damage to plant function or development. Generally a transient elevation in temperature, usually 10-15°C above normal is considered heat stress. Levitt (1980) proposed that the high temperature injury process progresses from a direct reversible strain, i.e., excess respiration over photosynthesis due to elevated temperatures, to an indirect strain, i.e., loss of reserves, or to a direct or indirect injury, i.e., starvation injury.

Global climate models predict an increase in mean ambient temperatures between 1.8 and 4.5°C by the end of this century (IPCC, 2007). Future climates will also be affected by greater variability in temperature and increased frequency of hot days.

Effect of heat stress on crop plants:

1. Growth and yield

High temperatures may cause scorching of the twigs and leaves along with visual symptoms of sunburn, leaves senescence, growth inhibition, and discoloration of fruits and leaves. Elevated temperatures can also reduce the germination potential of the seeds and, thus, results in poor germination and stand establishment. Unfavourable effect of these changes may drastically reduce growth, development and economic yield.

2. Reduction in photosynthesis

The heat stress also impairs the process of photosynthesis by disturbing the photosynthetic pigments reducing activity of photosystem II (Camejo *et al*., 2005) and impairing the regeneration capacity of RuBP (Wise *et al*., 2004). exposure to high temperature usually results in reduction in chlorophyll biosynthesis. Reduced accumulation of the chlorophyll in the plants may be due to either decreased biosynthesis of the chlorophyll or due to its increased degradation or combined effect of both under high temperature stress.

3. Imbalance in water and nutrient relations

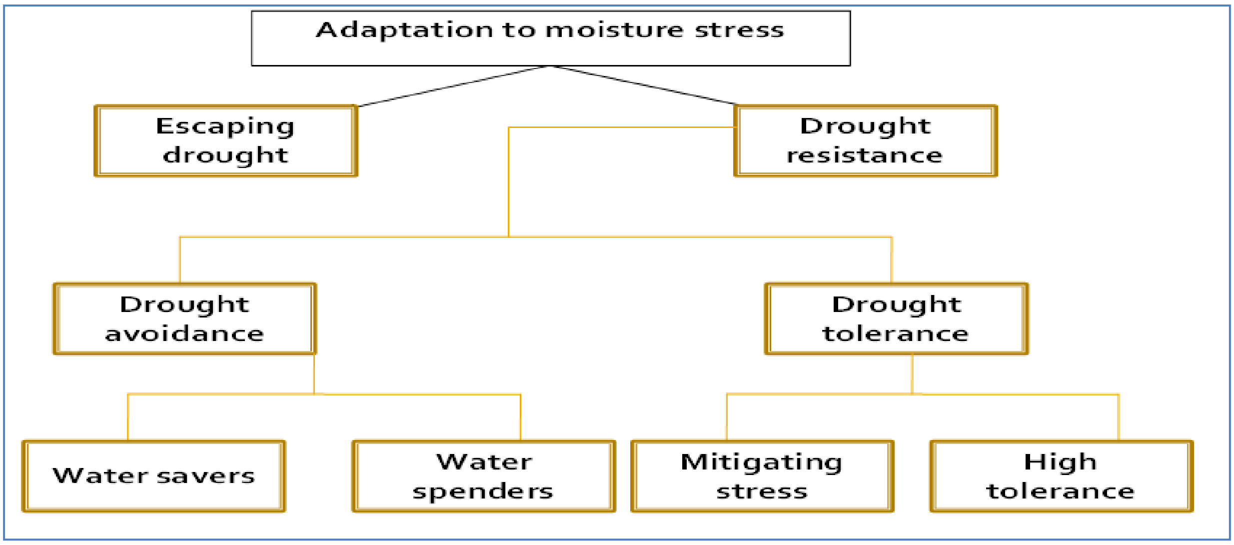
High temperature coincides with the water scarcity under field condition especially in tropical and sub-tropical environment and proves fatal under limited supply of water. Heat stress could also have a negative impact on the root conductance. Water loss under heat stress is more during day time mainly due to increased rate of transpiration, ultimately impairing certain important physiological processes in plants. Heat stress also reduces the number, mass and growth of the roots which ultimately limit the supply of water and nutrients to the above ground parts of the plant (Wahid *et al*., 2007). Reduction in nutrient uptake under heat stress might be due to various factors such as reduced root mass and nutrient uptake per unit root area. Activity of the major enzymes like nitrate reductase involved in the nutrient metabolism can also be significantly reduced under high temperature stress (Klimenko *et al*., 2006).

4. Denatured of protein

Light dependent chemical reactions taking place in the thylakoid and the carbon metabolism taking place in the stroma are the main sites of damage as a result of the high temperature stress. Direct injuries due to heat stress include protein denaturation and aggregation and increased fluidity of membrane lipids where as indirect include inactivation of enzymes in chloroplast and mitochondria, protein degradation etc.

5. Enzymes inactivation

Under high temperature stress the synthesis of starch and sucrose is greatly affected due to a reduction in the activities of important enzymes such as adenosine di-phosphate-glucose, pyrophosphorylase, sucrose phosphate synthase, and invertase. Net photosynthesis in many plant species is inhibited due to reduction in the activation state of the CO_2 binding enzyme, Rubisco.



6. Production of reactive oxygen species (ROS)

High temperature induces oxidative stress in various plants by production of reactive oxygen species (ROS like superoxide radical (O^{2-}), hydrogen peroxide (H_2O_2) and hydroxyl radical (OH^-). These are responsible of lipid per-oxidation, membrane injury, protein degradation, enzymes inactivation, pigment bleaching, and limiting growth and yield.

Crop adaptation to moisture stress:

Agro-technique for managing drought and heat stress

- **Nutrient management:**

Among the nutrient, potassium, magnesium, Zn, Fe and B are found to be deficient in drought. Therefore, foliar application of 2% diammonium phosphate (DAP), 0.5 to 1% potassium chloride and ferrous sulphate, 0.5% zinc sulphate, and 0.3% boric acid. This helps in drought resistance, thickness of cell wall, promoting superoxide dismutase (SOD) safeguard enzyme activity etc.

- **Use of anti transpirants:**

Anti-transpirants can effectively be used to the crop under drought stress which reduces water loss and maintain the temperature of plants. various type anti-transpirants can be used like phenyl mercuric acetate (PMA), Atrazine, ABA, Kaoline, cycocel (CCC), mobileaf and folicot.

- **Priming of seed:**

Seeds are partially hydrated to a point where germination related process begin. Priming of seeds hardens the protoplasm and enables the seeds to absorb more water under favourable situation to maintain its viability under unfavourable conditions. Chemicals like KCL (1%), KH2PO4 (1%), succinic acid, ZnSO4, ascorbic acid (100 ppm) and cycocel (250 ppm) etc.

- **Conservation agriculture**

Conservation agriculture ensure less run-off, weed suppression, less evaporation and better nutrition to the crops.

- **Soil and water conservation**

Stubble mulch tillage, zero tillage, mulching, broad bed and furrow, tied ridging, scooping, weed management, crop diversification and judicious nutrient management helps to mitigate drought and heat stress.

- **Use of plant growth Regulators (PGRs)**

Application of some PGRs like Cycocel, Cytokinins, Salicylic acid, Brassinolides and Ascorbic acid prove beneficial under drought and heat stress.

- **Adjusting sowing time**

Appropriate sowing time can be chosen which avoid stress period at sensitive stage.

- **Methods and time of irrigation**

Sprinkler and drip irrigation play important role in reducing due to drought and high temperature.

- **Effective weed management**

Effective weed management ensure less loss of water, nutrient and help the crop to escape stress.

- **Silicon application**

Application of silicon helps in growth, mineral nutrition mechanical resistance, higher stomatal conductance, photosynthetic rate and better water status make the plant resistance to these stresses.

Table 1. Crops varieties/hybrids tolerant to drought and heat stress

Crops	Drought tolerant	Heat tolerant
Rice	Poorva, Aditya, N 80, Heera, Pusa 1121, Saket 14, Govind	WH730, WH147, Halna, HD 2808, Raj3765
Wheat	Sujata, HW 2004, VL 606, K 9465, C 306	Sujata, HW 2004, VL 606, K 9465, C 306,
Sugarcane	Co 449, 617, 1307, CoA 8402, CoA7602	Co 449, 617, 1307, CoA 8402, 7602
Rapeseed-mustard	Pusa bold, Geeta, RH 781	Varden, Navgold, Cs56, Pusa mustard 26
Chickpea	CSG 8962, C 255, G 24	

ISA (2016), New Delhi

CONCLUSION

It may concluded that plants show a wide range of responses to drought and heat stresses which are mostly depicted by a variety of alterations in the growth and morphology of plants. Although drought and heat stress may cause negative effects on overall growth and development of the plants. To minimizing the negative effects of these abiotic stresses either by adopting the genetic approaches (resistant varieties) or standardized and use the agro-technique over the years. So there is need to strengthen the agro-technique to manage and mitigate the drought and heat stress for enhancing crop productivity.

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Beta-Glucan Fortified Functional Dairy Foods

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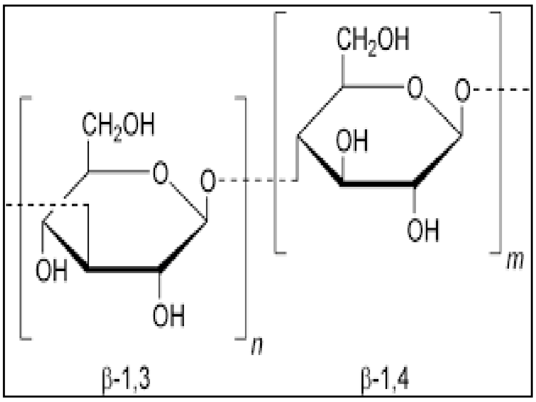
Glucans are glucose polymers, classified according to their interchain linkage as being either α- or β-linked. β-glucans are a heterogeneous group of nonstarch polysaccharides, consisting of D-glucose monomers linked by β-glycosidic bonds. β-glucans naturally occurring in the cell walls of cereals, bacteria, and fungi, with significantly differing physicochemical properties dependent on the source. The molecular weight of β-glucan varies between 50 and 3000 kDa. β-glucans are predominantly found in the internal aleurone and subaleurone cell walls. Typically, β-glucans form a linear backbone with 1-3 β-glycosidic bonds but vary with respect to molecular mass, solubility, viscosity, branching structure, and gelation properties, causing diverse physiological effects in animals. Cereal β-glucans from oat, barley, wheat, and rye induce a variety of physiological effects that positively impact health. Among cereals, the highest content of β-glucan on a dry weight (per 100 g) has been reported for barley: 2–20 g (65% is the water-soluble fraction) and for oats: 3-8 g (82% is a water-soluble fraction). Other cereals also contain β-glucan but in much lower amounts sorghum 1.1–6.2 g, rye 1.3-2.7 g maize 0.8-1.7 g, triticale 0.3-1.2 g, wheat 0.5-1.0 g, durum wheat 0.5-0.6 g, and rice 0.13 g Östman, et al (2006). Cereal-based β-glucans are soluble dietary fibers that strongly linked to improving cholesterol levels and boosting heart health Keogh et al., (2003).

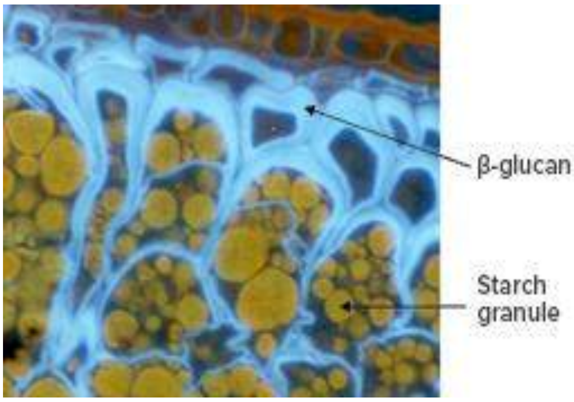
β-glucan is a relatively inexpensive milling byproduct, and it is added to foods that will contribute to health benefits. The manufacturing of food, β -glucans are used as a food additive in products such as salad dressings, frozen desserts, sour cream, and cheese spreads Liou, (2006). Nowadays, consumers have directed their interest towards reduced or low-fat products particularly, low-fat or non-fat dairy products due to potential health benefits and nutritional advantages. The low-fat market extension has forced dairy food manufacturers to devise products in order to satisfy demands of consumers. However, the retention of organoleptic characteristics in low-fat products is difficult, and they faced a lot of challenges in maintaining their quality Mahdian and Karazhian (2013).

Benefits of β-glucans

- ✓ Inhibit the free radical in body

- ✓ Stimulate the macrophage of the immune system
- ✓ Modulate an allergic immune of the physical conditions (Hypoallergenic)
- ✓ Prevent of infection and viral diseases
- ✓ Balance cholesterol and fasting blood sugar level
- ✓ Relieve inflamed rheumatism
- ✓ Lessen the suffer from constipation
- ✓ Enhance and maintain moisture within skin
- ✓ Wound healing and abirritate inflammation





Milk Beverage

The consumption of milk decreased as compared with a carbonated beverage. In United States, obesity has direction relationship with the consumption of carbonated beverages Oathman, et al., (2011). Milk-based beverages can act as ideal vehicles for bioactive compounds. β-glucan is one such component, which is viscous soluble dietary fiber. Brown, et al., (1999) reported FDA's approved β-glucan as an agent that lowers serum cholesterol. Products that make β-glucan more available in the diet can help contribute to a reduction in coronary heart disease (CHD) and associated health issues. Chatterjee and Patel (2016) prepared chocolate milk by using about 3 percent oat β-glucan to improve the mouthfeel and viscosity of fortified milk. After some days of storage does not change the product taste viscosity and there is no separation.

Non Fat Yogurt

In dairy products, milk fat plays a major role in their physical properties, rheological and textural characteristics and microbiological stability. In addition, fat influences other product characteristics such as handling, stability, appearance, flavor, and mouthfeel McIlveen and Armstrong, (1995). While most consumers are aware of the health benefits of low-fat diets, they are not prepared to sacrifice the taste, texture, and aroma they enjoy in the dairy products. So now a day's food industries goal is to respond to the consumer choice and increasing the varieties of low-fat products. Main problems associated with low-fat yogurt are rheological characteristics and increased syneresis so the product may be poorly acceptable. Keogh and O'kennedy, (1998) reported that production of low-fat yogurt can be achieved by incorporating fat replacer. Carbohydrate-based fat replacers, such as dietary fibers (DF) are the effective fat replacer in yogurt.

Extracted β-glucan concentrations were incorporated into the non-fat yogurt as a fat replacer. During storage at the refrigerator for 28 days physicochemical properties of yogurt i.e. acidification ki¬netic, color, physical stability and rheological properties were instrumentally evaluated. The application of β-glucan in skim milk yogurt improved the rheological properties and the physical stability of the product compared to the non-fat yogurt without β-glucan. Among all concentration 1.5 percent was best with a desirable attribute to that of a full-fat yogurt Mejri et al., (2014). Barley β-glucan was fortified in low-fat yogurts. The effects of β-glucan on the rheological, textural and sensory quality of low-fat yogurt-based products were determined. In β-glucan added low-fat yogurt shows reduced syneresis, improved texture, and rheological properties. The quality characteristics of β-glucan added low-fat yogurt similar with full-fat milk yogurt Brennan and Tudorica (2008).

LOW FAT CHEESE

Compared with full-fat cheese, in low-fat cheese, common defects are harder and more rubbery texture and inferior flavor characteristics usually encountered. In order to overcome these defects various suggestions have been made. With respect to the texture attributes, replacing milk fat with carbohydrate-based components are the best among them Aryana & Haque, (2001) and Romeih *et al.,* (2002). Among a number of polysaccharide-based fat mimetics, low Dextrose-Equivalent (DE) amylodextrins and cereal b-glucans could play multiple roles from a textural and functional viewpoint Sipahioglu *et al.,* (1999).

Volikakis et al., (2004), developed a low-fat white brined cheese from bovine milk by traditional method with 70 percent reduction of milk fat. Two levels of oat b-glucan concentrate Incorporated into the milk were 0.7 and 1.4 percent, respectively. Compared the low-fat cheese with control product, the fat content of cheese milk decreased, moisture in non-fat solids and yield significantly decreased, and the moisture and total nitrogen values increased. The yield of b-glucan cheese exhibited higher and during storage significantly lower pH (at 60 and 90 days) than the control samples.

LOW FAT ICE CREAM

Ice cream has a very complex structure, with multiple phases that can influence product textural quality and physical attributes including shape retention and structural collapse during melting Sonwae and Hembad (2014). It consists of a mixture of milk and milk components, sugar, stabilizers, emulsifier, flavoring and coloring materials. This product usually contains higher ratios of milk solids, not fat (MSNF) is the solids of milk, consists of protein, sugar, and minerals. The main role of MSNF in ice cream it helps to maintain smooth, enhance body and texture and gives a higher overrun Goff and Hartel (2013). To improve the acceptability properties of ice cream or as a cheap resource of ingredients to reduce the total cost of production. Several nonmilk solids have been substituted partially skim milk powder in ice cream products such as soy protein, potato pulp, Khoa, sodium caseinate and rice flour. Abdel-Haleem, & Awad, (2015) reported barley β-glucan about 0.4 percent added as a complete substitution of carboxymethyl cellulose to ice cream mix. All mixes and resultant ice cream samples were subjected for their physicochemical properties as well as the sensory quality attributes. All physic-chemical properties of β-glucan ice cream show the same manner of control.

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'Model Contract Farming Act': Challenges it need to address

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When all culture fails Agriculture prevails, it is an activity a social heritage. We are well aware of the plight of our ploughing hands and feeding lands. The well informed and ambitious governments step towards addressing the multi-pronged sufferings of farmers, by pragmatically reexamining its policy and laws. One of such measures is framing a 'Model contract farming Act". Contract farming is defined as "an agreement between farmers and processing or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices." Contract Farming is essentially an agreement between a resource rich parties such as, companies, Government bodies or individual entrepreneurs and the resource starved potential farmers. The salient aspects of Contract Farming is that the buyer/contractor supplies all the material inputs and technical advice required for cultivation to the cultivator in return to this the farmers seeking inputs sell predetermined quality produce to the contracting agency, it's like give and take game. Every innovation is born with limitations and confronted with challenges, the same is true for contract farming, and it also faces the "tit for tat" situation. This paper try to identify the probable challenges that a proposed law need to address.

Challenges

Challenges are those aspects that are bit hard to achieve or do, but not impossible. Following Challenges our law need to address. The socio-economic profile of the Indian farmers give us the area of actions.

Age of the farmers

Indian farmers are mainly middle to old age as we are well known of the interest and participation of today's youth in agriculture. The old mindset need to reorient towards modern crops and concepts. Farmers are satisfied and compatible with the mono-cropping and they resist to change cropping patterns. They are also the custodians of indigenous technical knowledge. So convincing them for taking up contract farming becomes challenging. In this situation what can be done is the law need to provide room for the experience of the farmers by organizing periodic interactions with the stakeholders. Most important is to attract youths in contract farming by providing social identity and brand to the occupation.

EDUCATION OF FARMERS

Majority of the farming community is illiterate and also digitally illiterate. Most of the farmers cannot be taken into confidence since they are suspicious on what is written in the contract, a provision of oral recording of the contract can be made and stored in database, all the contracts need to be signed in local language and script. Digital India initiative encompasses e- governance, to make best use of it, farmers' digital literacy needs to be increased.

Land holding of farmers

More than 80.00 percent of Indian farmers are marginal land holders. We are also well aware of the soil health of these holdings. Provisions for assistance of reclamation, leveling, drainage system need to be the imperative part of the input and technical supply of the contracting company.

Income of the farmers

The most vital aspect of farmers that is under surgery. The income of the farmers need to be distributed for his family basic needs, health, education, ceremonials and on farm inputs and debts. Due to low level of income farmers' life get imbalanced and he spend major share of his income on farm inputs. So to address this issue if the contracting company is made obliged to take up health and schooling facility for farmers as apart of social corporate responsibility, it would empower farmer and also attract towards contract farming. The doubling of income can be by means of saving what farmer earned by cutting the double expenditure.

Occupation

Farmers in India take up various agriculture and allied activates. The contracting needs to be in all these occupations. Livestock contracting need to be promoted, focusing mainly on indigenous cattle breeds. Some of the farmers take up secondary agriculture some room need to be provided in contract farming for such activities.

DECISION MAKING

Farmers are easily influenced by opinion leaders and peer groups. Few take collective decisions. Research says Authority innovation decisions are faster in adoption than other forms of decision. However our farmers take up decisions considering their prevailing situations. The law must provide space for collective decision and completely avoid impositions.

Risk bearing ability of farmers

Majority Indian farmers are not entrepreneurs they practice subsistence farming. It means they cannot bear the occupational risk. The probable risk in contracting, say meeting the required standards of the final produce, if the farmer fails to do so, he is not in a condition to bear the risk. Thus provision of procuring the produce and grading them and paying them according to set standards. Compulsory contracted crop must be insured and the medical insurance of farmers.

Cropping pattern and technological compatibility

Farmers in India practice different cropping pattern according to agro-climatic conditions. All the crops grown are not liable to processing or yet technology is not developed. The technology recommended by the contracting company must be compatible to cultural, situational and economic conditions of the farmers. Introduction of any crops or technology in our villages, first it must pass the cultural barriers, if the technology fails in cultural compatibility it will never prevail. It is very evident among the farmers of India that in a same village different crops are grown, different varieties and practices they follow. This differences indeed become hurdles in meeting expected quality by the companies. To cope up with the required standards of newly introduced crops farmers need to scale up their skills uniformly. The dynamics of change explains that initially change is resisted by any individual, as they are expertise and satisfied by the status quo. Skill upgradation, inculcation of new skills need to be taken up and such provisions need to be made. The farmers need to be united to take up cooperative and uniform measures by convincing them the relative advantages of doing so.

Monopoly of the private firms and jeopardize public agricultural research and extension system

Input supply and marketing are the two imperative aspects of farming. If both are the sovereignty of the contractor then our farmers are between the two jaws. Space for periodic government intervention need to give in the law. Contracting farmers have to be empowered to have collective bargaining capacity so that monopoly doesn't prevail. If a village or a region is completely brought under contract farming, it may result in jeopardizing the public agricultural research and extension system. The technology and recommendation of the contracting company must be assessed and get tested by the local public agricultural research centres. This may not jeopardize the public institutions.

Gender concerns

Most of the farmers are male, the provision of promoting female farmers need to be incorporated. In order to attract female participation and access to property rights, a provision of some added advantages if the contacting farmers holds property in the name of female member of family. Formation of contract farmer's wife association and providing them employment opportunity by outsourcing them in some semi-skilled and unskilled work such as making gunny bags, packing the produce, advertising the produce etc., as per the company requirements.

Corruption

Problems occur when staff responsible for issuing contracts and buying crops exploit their position. Such practices result in a collapse of trust and communication between the contracted parties and soon undermine any contract. Management needs to ensure that corruption in any form does not occur. On a larger scale, the sponsors can themselves be dishonest or corrupt. Governments have sometimes fallen victim to dubious or "fly-by-night" companies who have seen the opportunity for a quick profit. Techniques could include charging excessive fees to manage a government-owned venture or persuading the government and other investors to set up a new contract farming company and then sell that company overpriced and poor quality processing equipment. In such cases farmers who make investments in production and primary processing facilities run the risk of losing everything.

CONCLUSION

At the end whatever the law we make however well or bad it is framed, the success of the law depends on the ethical code of conduct of the implementing stake holders. All efforts need to be made to make it a tailor made law not a straitjacket law. The socio-economic profile of the farmers is least considered in our policies, it must be the central pillar around which new policies should be farmed. Farmers needs social identity, scientific price to their produce and brand to their occupation. I acknowledge Miss Shoja Rani B N for her valuable inputs presented at Conference on Global Competition & Competitiveness of Indian Corporate.

Modified Atmospheric Packaging:

A Crucial Post-Harvest Management approach to up-Keep Fruit Quality

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ABSTRACT
Modified atmospheric packaging refers to the approach of packaging a fresh or cut fruit using various packaging films, so that by virtue of the increased carbon dioxide concentration the gaseous concentration of the in-package environment gets modified. It directly impairs the respiration behaviour of the packed fruit. Hence the shelf-life of the packed fruit is improved retaining the optimal quality attributes. Without use of any external additives, the fruit life gets extended by virtue of the physiological behaviour of the same. This technology can be efficiently exploited as a consumer friendly, economical and scientifically sound technology in extending the self-life of perishables.

Key words: MAP, Quality, Shelflife, Packaging, Films

INTRODUCTION

In a developing country agriculture and horticulture is being considered as the primary profession for nearly fifty percent of its citizen. In horticulture production, India is in second position following China. Fruits have a comparative larger in the total Indian horticultural production. Owing to its positional specificity as well as the climatic peculiarities, a large number of fruits can be grown in India ranging from various strictly temperate to strictly tropical fruits. This provides the Indian fruit growers to have a broad choice of fruit orcharding, also a better purchasing options to the consumers. Although, Indian farmers are not that much technologically equipped, but owing to their sound experience and some advantages from the ecosystem the production has reached almost at its peak. The quality of produce is of not that much poor. But because of a large number of technical constraints our farmers cannot be confidant about their profit from fruit growing, as well as the consumers are also not that much sure about the fruit quality while purchasing such produce. Hence, now-a-days a consumer will prefer to purchase fruit from any shopping plaza with adequate confidence, rather than from the local fruit vendors. Hence, our fruit growers are not getting profit out of their production, although day-to-day the fruit need in the market is increasing. To sort-out such problem, the role or scientific community oriented with post-harvest research work cannot be ignored, rather they have to be in the prime focus. The various post-harvest management practices can be summarized as the set of activities followed from the point of harvest till reaches to the consumer's plate.

Among several post-harvest practices, packaging can be termed as a crucial one. The primary objective of packaging is to provide the product in a handy and attractive form to the buyer. Secondly, it takes an important role to retain the actual quality of the product. Packaging materials always used to protect the in-package product from the contact with various biotic and abiotic external stimuli. The biotic stimulus includes birds, pathogen, insects, etc. whereas, the abiotic stimulus includes the response due to fluctuating temperature, humidity, etc. The inherent quality of the fruit will be retained for a longer period when the action of various external deteriorating stimulus are not that much frequent. This forms the basic principle of the packaging technology. In case of fruits, the peel (epidermal cellular layer) acts as the natural packaging materials. Hence, some fruits such as citrus and apple can be kept for a longer period when there is no external injury to the rind.

IMPORTANCE OF PACKAGING TECHNOLOGY

Packaging is an old as practice since human used to adopt agriculture as a commercial profession. Packaging is an inseparable aspect of storage, whether it is for farm produces or for horticultural produces. The packaging materials also provide a plat-form to print various labelled about the product which is important with respect to the marketing point of view. Packaging technology enables the seller to sale it as a unit volume and the buyer to take it in handy forms. Some advanced technologies *viz.* controlled atmospheric technology, modified atmospheric technology, vacuum packaging technology, *etc.* provides a great scope to enhance the shelf life of the produce.

PACKAGING MATERIALS

Easily available and non-reactive materials are always preferable for packaging. Bamboo baskets and wooden boxes are being used for packaging of various fruits from an ancient time. Because of some problems like heavy weight, more chances of bruising, non-availability of enough woods, etc. the trend in selection of packaging materials is being shifted more towards the use of fibre boxes for perishable horticultural produces. Corrugated Fibre Board (CFB) boxes are the mostly preferable packaging materials. Card board boxes are also extensively being used. Currently, use of various low cost and easily available polymeric films *viz.,* LDPE, Cling films, etc. are becoming popular among the farmers to pack in field just after harvest. The use of such polymeric films also provides a scope of passive modified atmospheric packaging which is very much advantageous in soft perishable produce like strawberry. Apart from these, gunny bags are also used by the farmers to pack fruits like ber, which cause a huge post-harvest damage.

MODIFIED ATMOSPHERIC PACKAGING

The atmosphere of the in-package environment has a direct relationship with the biochemical processes of the fruits packed inside. The oxygen and carbon dioxide gas has a clear influence on the respiratory activity of the fruits, since it is a living entity. Hence, if by any means if the gaseous composition in the in-packed environment can be altered, the physiological process like respiration will definitely be altered. Such alteration can enhance the shelf-life of the fruit which is packed in a modified atmosphere. This is the basic principle behind the concept of modified atmospheric packaging.

Modified atmosphere (MA) means an atmospheric composition around the fruit that is different from that of normal air *i.e.,* 78.08 per cent N_2, 20.95 per cent O_2 and 0.03 per cent CO_2 (Kader, 1992). Such change in the gaseous atmosphere can be attributed to the factors like respiration and other biochemical processes of the produce and permeation of gases through the packaging film. It slows down the growth of aerobic microbes and the speed of oxidation reactions. A well-known benefit of MAP is to reduce high water loss by creating high humidity inside the packaging and with that the produce maintains freshness comparatively for a longer period. MAP is a dynamic process which depends on respiration of the product and permeability of the film simultaneously. The most crucial factors responsible for MAP of any fruit are the permeability of the packaging film and the respiration rate of the fruit. The permeability of the packaging film is mainly dependent on the thickness of the film and type of the polymer. Although the innovations and development of food packaging technology will continue to promote the development of novel MAP, concentrated research and endeavors from scientists and engineers are still important to the development of MAP that focuses on consumers' requirements, enhancing product quality, environmental friendly design, and cost-effective application (Zhang *et al*, 2016).

The desired modification in the in packaging environment can be done by two approaches – *Active modified atmospheric packaging* and *Passive modified atmospheric packaging*.

ACTIVE MODIFIED ATMOSPHERIC PACKAGING

In any of the scientific approach, the word 'active' refers to the use of energy or any other form of external resources. Hence, fundamentally active modifies atmospheric packaging approach can be well understood as a scientific approach in which external energy or any other agents are deployed so as to have a desired modification in the in-package gaseous composition. External energy is used to remove the optimal concentration of oxygen gas and to feel the package with inert nitrogen gas. Hence, the high speed respiration rate of the packed product can be controlled so as to have a better shelf-life retaining the desirable quality. Some ethylene absorbers like $KMnO_4$ are quite popular to have the advent of this approach.

PASSIVE MODIFIED ATMOSPHERIC PACKAGING

Passive modified atmospheric packaging is another approach of modification of the in-package gaseous environment where neither any of the external energy source nor any input is being used. After a fruit is harvested, being a living entity its respiratory attitude still persists. Hence, by virtue of respiration, carbon dioxide is generated with consumption of the oxygen still the optimum gaseous level in the in-package environment favours it. When, the level of carbon dioxide concentration crossed beyond the optimum level, it suppresses the normal respiratory activity. The gaseous permeability of the packaging film as well as the ability of the fruit to tolerate higher carbon dioxide concentration greatly determines the success rate of the technology. Low cost polymeric films available in the local market can widely be used for this approach by the common Indian farmers.

CONCLUSION

Technological refinement is an outcome of day to day scientific research and thoughts. But the researcher should focus on the feasibility as well as the acceptability of the technology by the all section of the users. Modified atmospheric packaging is such an excellent post-harvest management approach, which can widely be used for a number of fresh as well as cut fruits. There is a need to have deep study on various packaging films as well as on the molecular changes of the packed products.

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Dryland Agriculture:

Soil & Water Conservation Techniques

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Growing of crops entirely under rainfed conditions refered as dryland agriculture. Dryland agriculture can be grouped into three categories based on the amount of rainfall received:

1. **Dry Farming**: Cultivation of crops in areas where rainfall is less than 750 mm per annum
2. **Dryland Farming**: Cultivation of crops in areas receiving rainfall above 750 mm
3. **Rainfed Farming**: Cultivation of crops in regions receiving more than 1,150 mm.

PROBLEMS OF CROP PRODUCTION IN DRYLAND

1. **Inadequate and uneven distribution of rainfall:** Due to low and highly variable rainfall results in uncertain crop yields. The distribution of rainfall during the crop period is uneven, receiving high amount of rain, when it is not needed and lack of it when crop needs it.
2. **Late onset and early cessation of rains:** The sowing of crop are delayed due to late onset of monsoon, resulting in poor yields. Rain may cease very early in the season exposing the crop to drought which reduces the crop yields considerably
3. **Prolonged dry spells during the crop period:** Dry spells when prolonged during crop period reduces crop growth and yield and when unduly prolonged crops fail.
4. **Low moisture retention capacity:** Due to low moisture holding capacity in red and coarse textured soil, crops raised on suffer due to lack of moisture whenever prolonged dry spells occur. Loss of rain occurs as runoff due to undulating and sloppy soils.
5. **Low Fertility of Soils:** Due to lack of adequate soil moisture, there is limited scope for extensive use of chemical fertilizers.

SOIL & WATER CONSERVATION TECHNIQUES

I. Agronomic Measures

1. **Summer Ploughing:** Ploughing the field across the slope during hot

summer to opening up of the soil crust accompanied by deep ploughing and simultaneously overturning of the soil underneath to disinfect it with the help of piercing sun rays. Perform deep summer ploughing during May to recharge the soil profile. It facilitates to sow the crops immediately after onset of southwest monsoon. It increases water content of soils and reduces runoff and also reduces pest and weed infestation. At best two summer ploughings are done prior to advent of monsoon at an interval of 15-20 days. Third ploughing can be done once with the help of harrow or cultivator to pulverize the soil and prepare field beds for sowing/transplanting soon after the first monsoon rain.

Benefits of summer ploughing: Due to breaking of hard crusted upper layer of the soil and deep ploughing, the infiltration capacity and permeability of the soil increases which increases in-situ moisture conservation. Due to alternate drying and cooling, improves soil structure. Which helps in multiplication of micro-organisms. Organic matter docomposition is hastened resulting in higher nutrient availability to the plants. Helps in degradation of herbicide and pesticide residues and harmful allelopathic chemicals exuded by root of previous crops and weeds which inhibit the growth of other near by plants. Atmospheric nitrate mixed with water enters the soil and it increases soil fertility. The sharp rays of sun enters the soil and kills the eggs, larvae and pupae of soil borne insects and pests, Consequently the farmer's expenditure in procuring insecticides and pesticides decreases. Due to exposition to heat of summer, harmful bacteria spores and fungal microbes die. Purchasing fungicides and pesticides reduces. Controls nematodes. Helps in weed control which result reduction in competition between the crops and weeds. Water erosion of soil is restricted.

2. **Ridges and furrows:**

Ridges and furrows provides more infiltration time. Hence, the removal of soil along with nutrients is checked to a greater extent leading to increment in soil fertility and crop yield. Which is one of the various in situ soil and water conservation methods for black and red soils cause an increase of up to 15 per cent in crop yields.

3. **Contour farming**

Ploughing, planting and weeding along the contour, i.e, across the slope rather than up and down. Experiments show that contour farming alone can reduce soil erosion by as much as 50% on moderate slopes. Contour ridges are used mainly in semi-arid areas to harvest water, and in higher rainfall areas. Grass barrier strips planted along the contour. They are planted with fodder grass such as Napier, or are left with natural grass. They are effective soil conservation measures on soils that absorb water quickly, and on slopes as steep as 30%. Contour farming is farming with row patterns that run nearly level around the hill not up and down the hill. Farming is done across the slope so that there are no steep slopes on the field.

Benefits : Contouring can reduce soil erosion. By reducing sediment and run off and increasing water infiltration. Promotes better water quality. It gives 10-15% additional yield.

4. **Ploughing across the slope**

Ploughing the sloppy land across the slope and have the corrugation termed due to subsequent ploghing as such without leveling Sowing can be done.

Benefits: It increases moisture conservation in situ. Prevents wash out of fertilizers and plant nutrients applied by the farmer. Production of crops increases because of increased availability of water and plant nutrients. Energy of flow being reduced, erosion of top soil is drastically reduced. With multiple cropping the net economic returns of the farmer will be enhanced.

5. Vegetative Barriers

Is a strip planted with a grass or shrub that runs across the slope. It slows down water flowing down the slope and catches the sediment that has been eroded uphill. Over time, soil may build up behind the strip.

Vettiver Plantation: Slope of the land is <1% planting of vettiver, kollukattaipull, supapul, velimasal, gliricidia and lemon grass in across the slope as vegetative barriers. Vettiver can be planted in 15-20 cm interval in a paired row system. According to sloppiness vegetative barriers could be planted at 30-50 metre distance.

Salient features

It yields good benefits in the dryland soils. During heavy rainfall, barriers checks the run-off water which carrying potential soil from the land. It checks soil erosion and conserve moisture through reduction in velocity of water flow. Reduction in run off velocity increased the infiltration rate, only clear water alone will flow out of land. Vegetative barriers are cheap and easy to establish.

6. Inter cropping

Growing of two or more crops simultaneously on the same piece of land with a definite row pattern.

Some of the cropping patterns

No.	Region	Intercropping system
1	North east	Groundnut + Sorghum Groundnut + Pulses (Redgram)+ Castor
2	North west	Groundnut + Pulses (Redgram) Sorghum + Lab lab Groundnut + Castor Cotton + Black gram
3	Western	Groundnut + Castor Groundnut + Redgram Sorghum + Redgram Groundnut + Sunflower
4	Southern	Sorghum + Sunflower Cotton + Black gram Cotton + Cluster bean

Benefits: Promote the full use of crop land water by plant roots. Increases the water storage in root zone. Reduces the inter-row evaporation and control excessive transpiration. Create special microclimate advantageous to the plant growth and development. Increase the crop yield per unit area greatly without increase of water consumption, so as to promote the crop water use efficiency effectively.

7. **Crop rotation:**

Crops are changed year by year in a planned sequence.

Various Crop rotations:

- Pearl millet and Groundnut
- Gingelly and groundnut
- Groundnut and pulses
- Groundnut and ragi
- Groundnut and gingelly
- Maize and groundnut

Table No. 2: Potential cropping system based on rainfall and soil characteristics

Rainfall (mm)	Soil type	Growing season (weeks)	Profile storage capacity (mm)	Suggested cropping system
350-600	Alfisols, shallow vertisols	20	100	Single rainy season cropping sorghum / maize / soybean
350-600	Deep aridisols, Entisols(alluvium)	20	100	Single cropping sorghum / maize / soybean in kharif / rabi
350-600	Deep vertisols	20	100	Single post rainy season cropping sorghum
600-750	Alfisols, vertisols, entisols	20-30	150	Intercropping 1. Sorghum & Pigeon pea 2. Cotton & Black gram
750-900	Entisols, deep vertisols, deep alfisols, inceptisols	30	200	Double cropping with monitoring 1. Maize & safflower 2. Soybean & chick pea 3. Groundnut & horsegram
> 900	As above	> 30	> 200	Assured double cropping Maize & chick pea Soybean & safflower

- Groundnut and coriander
- Maize and pulses - pulses
- Horse gram/ pearl millet/ pulses/ ragi/ minor millet

8. **Strip cropping:** Strip cropping involves planting crops in strips across the slope, with alternate strips of grain and/or forage crops. Strip cropping combines the soil and moisture conserving properties of cross-slope farming with the soil building advantages of a crop rotation and is more effective in reducing soil losses.

Forms of strip cropping are:

- **Field strip cropping:** A specialized strip cropping where crops are planted in parallel bands across a slope but do not follow contour lines; bands of grass or other close-growing species are alternated with the bands of cultivated crops.
- **Contour Strip Cropping:** Is the growing of a soil-exposing and erosion permitting crop in strips of suitable widths across the slopes on contour, alternating with strip of soil protecting and erosion-resisting crop.
- **Wind Strip Cropping :** Planting tall-growing crops such as jowar, bajra or maize, and low-growing crop in alternately arranged straight and long, but relatively narrow, parallel strips laid out right across the direction of the prevailing wind regardless of the contour.
- **Permanent or Temporary Buffer Strip Cropping:** The strips are established to take care of critical, i.e.

steep or highly eroded, slopes in fields under contour strip cropping.

Purposes: Reduce soil erosion from water and wind. Strip Cropping reduces the rate of soil erosion and the runoff velocity. Increasing the infiltration rate of the soil under cover condition. Reduce the transport of sediment and other waterborne contaminants. Protect growing crops from damage by windborne soil particles. Improve water quality.

9. **Mulching:** Mulch is a material placed on the soil surface to maintain moisture, reduce weed growth, mitigate soil erosion and improve soil conditions. Mulch can either be organic such as grass clippings, straw, bark chips and similar materials or inorganic such as stones brick chips and plastic. Conservation tillage is a common practice that creates mulch on the soil surface. It leaves the crop residue on the top of the soil as mulch.

Benefits

Improves the soil structure and increases the infiltration-capacity of the soil. Protects soil from erosion. Conserve moisture in soil thus saving the need for frequent irrigation. Reduce compaction of soil due to impact of heavy rains. Maintains a more even soil temperature. Prevents weed growth to check loss of soil nutrients. Crop residues act as a mulch and reduces soil evaporation. Sorghum stalk spread over 40 cm depth with 15 cm wide in the beds increased 20-30% crop yield . Coir waste can hold water five times as of its own weight. It enriches soil by adding organic matter and reduces weed infestation.

10 . **Soil amendments application**

Soil amendment includes all inorganic and organic substances mixed into the soil for achieving better soil constitution regarding plant productivity. There are different substances for different soils and plants to optimize the soil conditions. A very common amendment is the addition of organic matter like compost, due to its low production costs.

Suitable organic amendments : Organic amendments consist of material derived from living things (e.g. plants) or the by products of processing plants or mills (saw dust, chips, bark, bagasse, rice hulls) or waste disposal plants (compost, processed sewage sludge). The main purpose of using organic amendments is to loosen the soil and create large pores to increase

Benefits of amendments application: It provide a better environment for roots and plant growth. Improvement of the soil structure and water holding capacity. Increases the availability of nutrients. Improves living conditions of soil organisms. Better soil texture and better root growth avoids soil degradation during heavy rains. Increase aeration. Increase drainage.

11. Chisel ploughing

Chisel plough is a common tool to get deep tillage (prepared land) with limited soil disruption. The main function of this plough is to loosen and aerate the soils while leaving crop residue at top of the soil.

Benefits of chisel plough: Loosen and aerate the soil. Reduces the effect of compaction. Can help break up hardpan. Reduces soil erosion low till farming conditions. Prevents formation of surface crusts, which helps water to infiltrate the soil. Chisel ploughing severe weed roots below the surface.

12. Alternate Land use pattern:

Systems such as range/pasture management and for tree farming and ley farming, dryland horticulture and agro-forestry systems including alley cropping which are alternative to crop production are called as alternate land use systems

Agro-forestry: Agro forestry is an integration of agricultural crops with trees in the same piece of land. Agro forestry will provides food, fodder for cattle and develop environment and enriches the soil.

Benefits of Agro-forestry system: It increases gross income of the land. Supplies furniture wood, fuel and fodder. Checks soil erosion. Enriches the soil. Controls wind velocity there by reduce the crop damage. Reclamation of problematic soils. Regulates soil temperature.

Benefits of Agri-horticulture: Soil and moisture conservation. Increased production. Increased profit. Additional employment opportunity. Processing and allied industries. Solves nutritional requirement.

Silvi-pastoral system : Growing of tree species and forage crops in given unit area of land.

Trees	**Forage crops**
Soundal	Fodder cowpea
Acacia sp	Fodder sorghum
Vagai	Kollukattaipull
	Hedge lucerne
	Kudhiraimasal

II. Engineering Measures

1. Broad beds and furrows

In a broad bed-and-furrow system, runoff water is diverted into field furrows (30 cm wide and 30 cm deep). The field furrows are blocked at the lower end. When one furrow is full, the water backs up into the head furrow and flows into the next field furrow. Between the field furrows are broad beds about 170 cm wide, where crops are grown.

Function	**To control erosion and to conserve soil moisture in the soil during rainy days**
General information	It is suitable when the slope of the land is < 3% The broad bed and furrow system is laid within the field boundaries. The land levels taken and it is laid using either animal drawn or tractor drawn ridgers.
Cost	Approximate cost for laying beds and furrows is Rs. 1000/- per ha.
Salient features	Conserves soil moisture in dryland Controls soil erosion. Acts as a drainage channel during heavy rainy days

2. **Contour Bunding:** To intercept the runoff flowing down the slope by an embankment.

Salient features: It can be adopted in light and medium textured soils. It can be laid upto 6% slopes. It helps to retain moisture in the field.

Situations for various bunding options:

Bunding options	Soil type	Rainfall (mm)	Slope (%)
Contour bund	Light soil	<600	>1.5
Graded bund	All soils	<600	1.5
Bench terraces	Deep soil	>1000	6.0
Graded boarder strip	Deep Alfisol and related red soil	>800	>1.5

In-Situ Moisture Conservation Techniques :

Soil Type	Rainfall	In-Situ Moisture Conservation Techniques
Red soil	Low	Dead furrow at 3-6 m interval
	Medium	Sowing on flat bed and riding later with eventual cultivation
	High	Graded border strips
Black soil	Low	Contour cultivation
	Medium	Dead furrows at 3-6 m interval
	High	Graded open furrow (0.2 to 0.3 m3) at 10 m interval across the slope

3. Contour trenches and staggered trenches:

It was suitable where slope of the land is > 33.33%. Dimension of trenches- 2 x 1 x 1 m^3. Trenches are excavated in contours and excavated soil was used to form bunds in the down line. The trenches were formed in 5 to 10 feet vertical distance. It helps to reduce velocity of water. It checks soil erosion.

4. Contour stone wall

Contour stone wall is constructed where the slope is > 15 to < 30% under the guidance of engineers. In case of highly hill areas, contour trenches were constructed along with stone wall. It is suitable for shallow and gravel soil. It is recommended where difficult to construct bench terrace. It helps in land preparation and checks soil erosion.

5. Compartmental bunding

The entire field is divided into small compartments with pre determined size to retain the rain water where it falls and arrest soil erosion. Which are formed using bund former. The size of the bunds depends upon slope of the land, provide more opportunity time for water to infiltrate into the soil and help in conserving soil moisture.

Salient features: Compartmental bunding is an effective moisture conservation measure in dryland. It is suitable for lesser rrainfall areas and the slope is < 1%. The lands are divided into small compartments with the dimension of 8 x 5 m2. Small compartments act as a dam and store the rainfall received in the compartments for longer period. It increases water holding capacity of the soil. It can be formed while ploughing itself or before early sowing. Reduces the formation of cracks. It will overcome the disadvantages of contour bunding.

6. Random Tied ridging

The ridges are vertically tied at shorter interval to create rectangular water harvesting structures. During heavy rainy season it facilitates to infiltrate water to the soil. The slight sloppiness in the tied ridges facilitates draining of excess water infiltrate into the soil. Summer ploughing, broad bed and furrows, ridges and furrows, random tie ridging, compartmental. bunding etc. are the various in situ water harvesting methods for black and red soils cause an increase of up to 15 per cent in crop yields. It conserves soil and moisture in redsoils.

7. Basin listing

In this method of soil and water conservation basins are constructed using a special implement called basin-lister. These basins are constructed across the slope. Basin listing provides maximum time to rain water for infiltration into the soil.

8. Bench terracing

On steeply sloping lands, the slopes where such terraces are found useful vary from 6 to 30 per cent. Bench terraces with 100 m length, longitudinal grades in the range of 0.2 to 0.8 per cent are recommended for Alfisols of high rainfall regions. Bench terraces are suitable where soil depth is more than 21/2 feet and it can be laid in slopy land ranges from 16.67 to 33%. In highly slopy lands (8-15%) three types of bench terraces are planned viz., horizontal, inward and outward based on soil type and water holding capacity. In hilly areas, cultivation of horticultural crops under bench terracing method conserve soil, moisture and reduces nutrient loss and increases the yield. It also reduces soil erosion

9. Micro Catchment

In drylands, quantum of rainfall is not sufficient for the cultivation of crops , if tree cultivation is possible means developing micro catchments around the tree will improve the storage of rainfall and increase the yield. In slopy land this type of catchments could be developed across the slope. For tree crops, according to inter space available catchments are formed. It stores rain water where it falls and helps in growth of trees. For plain and hill areas the shape of the bunds were decided.

Circular and semicircular basins: It is suitable for fruit crops. Bundings were for formed individually for each tree. Circular bunding recommended for plain land area, whereas sloppy lands with semicircular or crescent bunding. Distance between bunding depends upon tree spacing

'V' ditches: In the land areas at 4 to 6 m intervals V shaped ditches are formed with the help of machine or animal drawn machine. Down the line of ditches covered with soil bunding and the trees are planted in the pits based on the spacing needed.

10. Farm ponds

Farm ponds are small water bodies formed either by the construction of a small dam or embankment across a waterway or by excavating or dug out. The water is usually harvested from a small catchment area and then used for irrigation during prolonged periods

Benefits of farm ponds : It collects excess runoff during rainy period. Stored water can be used for supplemental irrigation to crops. It is useful as drinking water for cattles during drought situation. It can be used for spraying pesticides. It conserves soil and moisture.

11. Percolation ponds

Percolation ponds are small ponds located mostly in low lying areas of poromboke lands and formed in order to store the run-off of rainwater and to allow it to percolate downwards and sideways. Deep ponds are preferred since evaporation of the stored water therein will be less. It has been observed that the percolation ponds are effective up to a distance of 1000 metres on the downstream side and wells within this range are benefited with more replenishment of water.

Benefits: It replenish ground water during rainy season. It reduces velocity of water thereby reduce soil erosion. Reduces siltation in water tank, ponds and check dams. Floods can be avoided. Generates employment during dry period. Increased cultivable area. Points to be considered. Area should't be hard and rocky. Capacity of the ponds depends upon amount and frequency of water flow. In the downstream there should be farm lands and irrigation well. The depth should be atleast 1.5 m. The depth should be atleast 1.5 m. Strengthen the bunds with soil .

12. Check dams: Check dams constructed across gullies will serve as an effective water harvesting structure like mini percolation ponds. Even though their main purpose is for controlling the development of gullies, series of check dams across a gully course will help augment the filling up of water in the existing wells nearby on both sides of the gully. Check dams is an structures built on at 500 feet distances in water canal.

SALIENT FEATURES

Check dams at suitable intervals should be constructed to avoid gully formation and to control soil erosion and recharge ground water. The stored water can be used to grow crops. Situation like Contour bunding or other soil and moisture conservation practices are not adopted means it will cause soil erosion due to rainfall and developed gullies. Finally land will not suitable for cultivation. The water can be used for Agriculture purposes; Fish rearing and increased the utility of water based activities. It can be built as permanent concrete structures or with stones, Bamboo and wooden planks as temporary measure. To improve localized irrigation facilities by developing a network of checkdams, streams and canals. Check dams facilitate infiltration of water into the soil. Check dams store water. Check dams Control runoff and accelerates recharging. Check dams provide enough time and space for the water to soak into the soil.

FACTORS TO BE CONSIDERED

Factors such as runoff, depth and width of the stream/river. people's participation. Availability of manpower and construction materials. Other local peculiarities etc. need to be taken into consideration during the planning and designing of check dams.