About the book

The book on the contemporary theme of agriculture farming deals with the significant concept of sustainable farming from multiple perspectives. It elaborates at length the principles and practise of sustainable farming. Innovation in agriculture technology and conservation of biodiversity are crucial to solving problems of food security and environmental sustainability. The basic theme of the book is innovative approach in agriculture farming is for enhancing crop productivity and this has been emphasized in most of the chapters. The content of the book is aimed to benefit the researchers, teacher's student and various stakeholders. The book is structured into various chapters and primarily for the degree, postgraduate students and for the researchers. The chapters are covering major aspects of innovative approach in agriculture and it is hoped that the book would be immense use to teachers, researchers as well as students and generate enough interest to inspire the inquisitive mind.
Innovative Approach in Agriculture Farming
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Nowadays agricultural issues are considered as the primary challenges in the world. India is one of the highest agriculture production country but production is depend upon high input of chemical fertilizers. Soil structure and food cycle is nowadays a matter of greater concern. Chemical fertilizers increase the production but it alters the quality of water, soil and air. These chemical can harm human and animal health and creating serious health issues when food material is utilize as grain and fodder. New technological approaches have to be necessitated as unlike other natural disasters, that can help to prevent this issue. While adopting the technique, one should keep in view the future perspective of the crises, i.e. the growing population, environmental damages and also the depletion of natural resources. Traditional techniques alone cannot fill the required criteria. Alternative measures need to be sorted out and thus innovative approach is in urgent need of action. But in order to adopt the technique, farmers play a crucial role and the awareness of the farmers for the technology has to be evaluated firstly. So this book innovative approach in agriculture farming relates to cope up with future challenges emphasizing on the applications of the techniques and the need for its adoption.

The basic theme of the book is innovative approach in agriculture farming is for enhancing crop productivity and this has been emphasized in most of the chapters. The book is structured into --- chapters and primarily for the degree, post graduate students and for the researchers.

I wish to express our deep sense of gratitude and indebtness to those who helped us directly or indirectly during the preparation of the manuscript of this text. I specially thankful our co editors who have toiled along with me in editing the voluminous treaties.

I hope that the book is useful and interesting to readers, teachers and students and would create in them the urge to know more about recent researchers going related to agriculture farming for enhancing crop productivity.

Dr. Joginder Singh
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INTRODUCTION

Broodstock nutrition is one of the least researched areas in fish nutrition due to massive facilities required for holding large groups of adult fish, and running costs involved in maintaining such facilities have been the main deterrents. Broadly, it is understood that many of the problems encountered in the early life stages of rapidly growing larval and juvenile fish can be related to the feeding regime (including the nutrient level and duration) of the brood stock. Therefore, brood stock feeding management should aim at providing the brood fish with feed that results in optimum reproductive performance with regard to time of first maturity, number of eggs produced (fecundity); spermatogenesis that affect fertilization rate; embryonic development, hatchability and larval viability.

FOOD RESTRICTION AND DIET QUALITY

Gonadal maturation and spawning success are affected by food restriction. Inhibition of gonadal maturation, delay in spawning time, abnormality in eggs as well as newly hatched larvae are common indicators of food restriction when compared with fish fed full rations. Since fecundity becomes established early in ovarian development and as yolk protein constitute >80% of the egg dry weight, food restriction at the beginning of development of the ovaries (Vitellogenesis) may reduce egg production (Pepper and Crim, 1996). Studies showed that feeding trout broodstock with half or three-quarter of their recommended daily ration (0.5 -1% of body weight per day) resulted in up to 25% reduction in egg production coupled with delayed spawning time. Also, the detrimental effects of food restriction in female seabass was associated with reduced plasma estradiol levels (Cerdá et al., 1994a).

Another important aspect of broodstock feeding is that of the diet quality which have both direct and indirect effects on egg production, egg size and probably egg quality (Bromage et al., 1992). Although there may be need for specific nutrients by a particular species, the following nutritional components listed in Table 1, regardless of species, are indispensable for improved reproductive success and should not be undermined during broodstock diet formulation.
Table 1. Important broodstock nutrients

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<th>Nutrient</th>
<th>Source</th>
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<tr>
<td>n-3 HUFAs</td>
<td>Marine oils</td>
<td>1-2%</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>-</td>
<td>250 ppm</td>
</tr>
<tr>
<td>Carotenoids</td>
<td>Astaxanthin</td>
<td>100 ppm</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Stable vitamin C</td>
<td>200 ppm</td>
</tr>
<tr>
<td>Amino acids</td>
<td>Marine animal protein</td>
<td>80% of dietary protein</td>
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**Source:** Fish Site

**Nutrition and fecundity**

Fecundity is the total number of eggs produced by each fish expressed either in terms of eggs/spawn or eggs/body weight. Reduced fecundity is caused either by the influence of a nutrient imbalance on the brain-pituitary-gonad endocrine system or by the restriction in the availability of a biochemical component for egg formation.

One of the major nutritional factors that have been found to greatly affect reproductive performance in fish has been the dietary essential fatty acids content which in turn significantly influences egg quality in a short period of time (Watanabe et al., 1984a,b; Harel et al., 1992). In rabbit fish (*Siganus guttatus*) elevation of dietary lipid levels from 12% to 18% resulted in an increase in fecundity and hatching (Durray et al., 1994). Fecundity in gilthead seabream (*Sparus auratus*) was found to significantly increase with an increase in dietary n-3 HUFA levels up to 1.6% (Ferna´ndez-Palacios et al., 1995). But studies on *Oreochromis niloticus* indicated that the reproductive performance were more enhanced when fed diets high in n-6 fatty acid. However, dietary supplementation of both n-3 and n-6 PUFA, is essential to improve gonadal maturation, breeding performance and spawn recovery in the *Catla* female broodstock.

Polyunsaturated fatty acids (PUFA) and highly unsaturated fatty acids (HUFA) have very vital roles as in any organism due to which they are known as essential fatty acids (EFA). PUFA regulate eicosanoid production particularly prostaglandins, which are involved in several reproductive processes (Moore, 1995), including the production of steroid hormones and gonadal development such as ovulation. Apart from dietary EFA deficiencies causing detrimental effects in fish, their excess have been also reported to have a negative effect on reproductive performance of fish. For example, high levels of dietary n-3 HUFA reduced the total amount of eggs produced by gilthead seabream broodstock despite an increase in egg n-3 HUFA concentration (Ferna´ndez-Palacios et al., 1995). High dietary n-3 HUFA could also affect the brain–pituitary–gonad endocrine axis since both EPA and DHA have been found to reduce *in vitro* the steroidogenic action of gonadotropin in the ovary of teleost fish.
Other nutrients proven to have profound effects on broodstock performance are Vitamin E and Vitamin C. An increase in dietary \( \alpha \)-tocopherol levels have been reported to improve fecundity in gilthead sea bream as expressed by the total number of eggs produced and egg viability. Vitamin C content of eggs of some species are relatively high suggesting the content of this micronutrient in the diet should be increased and was associated with improved egg quality. (Halverand Hardy, 2002). Dietary tryptophan, a precursor of the neurotransmitter serotonin, may positively affect gonad maturation in both males and females. Supplementation of 0.1% tryptophan in the diets of ayu resulted in a significant increase in the serum testosterone levels thus advancing time of spermiation in males and induced maturation of females (Akiyama et al., 1996).

**BROODSTOCK NUTRITION AND FERTILIZATION**

Dietary eicosapentaenoic (EPA) and arachidonic acid (AA) levels show a correlation with fertilization rates. Sperm fatty acid composition depends upon the essential fatty acid content of broodstock diet, and may affects sperm motility and in turn fertilization. Both EPA and AA are involved in cell-mediated functions and are precursors of eicosanoids. EPA is known to be a precursor of prostaglandins (PG) from series III, whereas AA is a precursor of PG from series II (Stacey and Goetz, 1982). There is also a positive effect when supplemental dietary vitamins are used, including vitamin E, C and carotenoids. The antioxidant function of vitamin E and C can provide protection for the sperm cells during spermatogenesis and until fertilization by reducing the risk of lipid peroxidation, which is detrimental for sperm motility.

**BROODSTOCK NUTRITION AND EMBRYONIC DEVELOPMENT**

Several nutrients, including proteins, essential fatty acids, vitamins and carotenoids, can significantly affect embryo development by improving egg morphology and hatching rates. A well balanced, essential amino acid profile can improve vitellogenin synthesis. EFA requirement in broodstock diets are in the range of 1.5 – 2.0% with under listed advantages during embryonic development.

- dietary HUFA improve the percentage of morphologically normal eggs, and egg quality and viability.
- as components of phospholipids and biomembranes
- Affect fluidity of membranes, physiological functions of bound membrane enzymes & also cell function
- AA and DHA/EPA contents in PL fraction of egg positively affect egg symmetry and viability
- Fatty acids in general are the major source of energy in early embryonic development which will also be used as source of endogenous feeding for the larvae through egg yolk formation.
Carotenoids constitute one of the most important pigment classes in fish, with a wide variety of functions including protection from adverse lighting conditions, a pro vitamin A source, chemotaxis of spermatozoa and antioxidant functions. Vitamin E, vitamin C and carotenoids e.g. astaxanthin, are strong scavengers of reactive oxygen species and have been shown to have a protective role against the action of free radicals that cause oxidative damage. The survival of embryo has also been shown to be affected by the vitamin C content of broodstock diets and are necessary for the synthesis of collagen during embryo development. Also, vitamin A is considered important for embryo and larval development due to its important role in bone development, retina formation and differentiation of immune cells.

**EFFECTS OF BROODSTOCK NUTRITION ON LARVAL QUALITY**

Several studies have shown the effect of broodstock nutrition on seed or larval quality. For example, increasing dietary lipid levels in broodstock diets can result in the production of large newly hatched larvae with an increased survival rate. Increasing essential fatty acids (particularly DHA) can significantly enhance the weight of some fish larvae and their resistance to osmotic shock. It can also improve the percentage of live larvae after yolk reabsorption, with survival and swim bladder inflation being improved when fish oil replaced soybean oil in broodstock diets of gilthead seabream. However, excessive levels of dietary n-3 HUFA levels (over 2%) can cause yolk sac hypertrophy and decreased larval survival in larvae of some species.

**VALUABLE FEED INGREDIENTS FOR BROODSTOCK NUTRITION**

Cuttlefish, squid and krill are considered to be the most valuable ingredients in broodstock nutrition. Feeding broodstock with the fat in soluble fraction of squid meal and cuttlefish meal can result in improvements in the total number of eggs produced, and the percentages of viable and fertilized eggs. The fat insoluble portion of cuttlefish meal and squid meal, is believed to be the reason for their beneficial effect on egg quality. Another important feed ingredient is raw krill, which has distinct quality-enhancing effects compared with fishmeal. For example, viable offspring production in red sea bream was more than doubled in terms of the percentage of buoyant eggs, total hatch, and normal larvae, when krill was included in broodstock feeds. However, soybean meal inclusion in broodstock feeds has a detrimental effect mainly because of the imbalance in the fatty acid composition. As a safe measure in broodstock feeding it is advisable to incorporate n-3 HUFA up to 2% and 250 mg/kg vitamin E.

**CONCLUSION**

Somatic growth continues uninterrupted in most fish species until combination of external and internal factors initiates sexual maturation during which somatic growth slows and gonadal development accelerates until the fish spawns. Feed quality during this period is known to affect the quality of offspring with nutrient requirement higher than those of juveniles, but excesses or imbalances can also be detrimental for reproduction. Therefore broodstock diets should contain
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certain amount of nutrients, like balanced amino acids, essential fatty acids, vitamins E and C, and carotenoids, to meet the nutritional needs of the reproducing fish.

REFERENCES

SALT AFFECTED SOILS IN INDIA AND THEIR MANAGEMENT STRATEGIES

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INTRODUCTION

Globally, 75 countries have been recognized as having vast areas of salt-affected lands. Martinez-Beltran estimated that nearly 831 million hectares of land are salt-affected worldwide. Salt-affected soils mostly exist in arid and semiarid regions of the world, and many salt affected waste lands have been productive lands in the past (Qadir et al. 2000). Worldwide, about 95 million hectares of soils are under primary salinization (salt accumulation through natural processes in soils and water) whereas 77 million hectares suffer from secondary salinization (as a result of human activities and ever-rising groundwater) (Metternicht and Zink 2003). Of major concern is that 23 % of the arable lands in the world are affected by salinity and a further 10 % are saline sodic soils while 340 million hectares of lands suffer sodality (NLWRA 2001; Szabolcs 1994). The high salt concentration negatively affects soil microbial activity as well as soil chemical and physical properties, thus causing a decline in soil productivity. Decline in vegetation growth due to salt toxicity and detrimental osmotic potential results in lower carbon (C) inputs into these soils and further deterioration of their physical and chemical properties (Wong et al. 2009). Accumulation of excess salts in the root zone resulting in a partial or complete loss of soil productivity is a worldwide phenomenon. The problems of soil salinity are most widespread in the arid and semi-arid regions but salt affected soils also may occur extensively in sub-humid and humid climates, particularly in the coastal regions where the ingress of sea water through estuaries and rivers and through groundwater causes large-scale salinization. Soil salinity is also a serious problem in areas where groundwater of high salt content is used for irrigation (Singh and Bhumla, 198) and the process is known as secondary salinization. The most serious salinity problems are being faced in the irrigated arid and semi-arid regions of the world and it is in these very regions that irrigation is essential to increase agricultural production to satisfy food requirements. However, irrigation is often costly, technically complex and requires skilled management. Failure to apply efficient principles of water management may result in wastage of water through seepage; over-watering and inadequate drainage result in water logging and salinity problems which reduce the soil productivity, eventually leading to loss of cultivable land.

The world as a whole is losing at least ten hectare of arable land every minute, five because of soil erosion, three due to soil salinization, one from other soil degradation processes and one from non-agricultural uses. The problem of soil degradation is a serious threat to the welfare of
mankind. Although degradation of the land has always characterized man’s systematic use of it, the process has accelerated in recent decades and precisely at a time when population growth and rising expectations have begun to demand enormous increases in food production. The problem is of overwhelming urgency. As the soil is subject to degradation, the cost of reclaiming it becomes higher, rising sharply until the threshold is passed beyond which reclamation is no longer economically feasible. Nearly 50 percent of the irrigated land in the arid and semi-arid regions has some degree of soil salinization problems. The problems of salt-affected soils are old but their magnitude and their intensity have been increasing fast due to large-scale efforts to bring additional areas under irrigation in recent decades. The problems have been made worse by development of irrigation systems without adequate provision for drainage and are being aggravated by poor water management practices and unsound reclamation procedures.

The general characteristics and basic principles involved in the identification, reclamation and management of salt-affected soils are the same throughout the world. However, differences from place to place in soil characteristics, climate, water availability, farm management capability, financial resources, available inputs and economic incentives lead to differences in method, extent and rapidity of soil reclamation. Although technical literature abounds with sound information on the subject, nonetheless, there are far too many partial or complete failures of efforts to reclaim salt-affected soils.

**ORIGIN, CLASSIFICATION AND DISTRIBUTION OF SALINE SOILS**

Salt-affected soils occur in all continents and under almost all climatic conditions. Their distribution, however, is relatively more extensive in the arid and semi-arid regions compared to the humid regions. The nature and properties of these soils are also diverse such that they require specific approaches for their reclamation and management to maintain their long term productivity. For any long-term solutions, it is, therefore, necessary to understand the mode of origin of salt-affected soils and to classify them, keeping in view the physico-chemical characteristics, processes leading to their formation and the likely approaches for their reclamation and successful management.

The presence of excess salts on the soil surface and in the root zone characterizes saline soils. The main source of all salts in the soil is the primary minerals in the exposed layer of the earth’s crust. During the process of chemical weathering which involves hydrolysis, hydration, solution, oxidation, carbonation and other processes, the salt constituents are gradually released and made soluble. The released salts are transported away from their source of origin through surface or groundwater streams. The salts in the groundwater stream are gradually concentrated as the water with dissolved solutes moves from the more humid to the less humid and relatively arid areas. The predominant ions near the site of weathering in the presence of carbon dioxide will be carbonates and hydrogen-carbonates of calcium, magnesium, potassium and sodium; their concentrations, however, are low. As the water with dissolved solutes moves from the more humid to the arid regions, the salts are concentrated and the concentration may become high enough to result in precipitation of salts of low solubility. Apart from the precipitation, the
chemical constituents of water may undergo further changes through processes of exchange, adsorption, differential mobility, etc., and the net result of these processes invariably is to increase the concentration in respect of chloride and sodium ions in the underground water and in the soils. Russian workers (Kovda, 1965) recognize the following sequence of changes in the composition of groundwater in relation to their concentrations (Table 1) as the water moves from humid to arid areas. Similar trends are observed with regard to the chemical composition of groundwater in India. Source-(Kovda et al, 1965)

Table-1 Extent of saline and alkali soil in different states of India

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Total (lakh ha)</th>
<th>Coastal saline soil (lakh ha)</th>
<th>Alkali soils (lakh ha)</th>
<th>Saline soil (lakh ha)</th>
<th>State</th>
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<td><strong>37.88</strong></td>
<td><strong>17.11</strong></td>
<td><strong>Total</strong></td>
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Source- CSSIR (Karnal)
i. **Saline soils** - Soils containing sufficient neutral soluble salts to adversely affect the growth of most crop plants. The soluble salts are chiefly sodium chloride and sodium sulphate. But saline soils also contain appreciable quantities of chlorides and sulphates of calcium and magnesium.

ii. **Sodic soils** - Soils containing sodium salts capable of alkaline hydrolysis, mainly Na$_2$CO$_3$, these soils have also been termed as ‘Alkali’ in older literature.

These two main groups of salt-affected soils differ not only in their chemical characteristics but also in their geographical and geochemical distribution, as well as in their physical and biological properties. The two categories also require different approaches for their reclamation and agricultural utilization. In nature the various sodium salts do not occur absolutely and separately, but in most cases either the neutral salts or the ones capable of alkaline hydrolysis exercise a dominant role on the soil-forming processes and therefore in determining soil properties. The distinguishing features of these two broad groups of salt-affected soils are presented in Table 3. Although the above two categories account for a very large fraction of salt affected soils the world over, there are transitional or borderline formations which are likely to have properties intermediate between those of the two broad categories. Several local terms in different parts of the world are in vogue to designate such soils. Other categories of salt-affected soils which, though less extensive, are commonly met in different parts of the world are:

ii. **Degraded sodic soils**

Degraded sodic soils are usually considered to be an advanced stage of soil development resulting from the washing out of salts. The details of the type of soil developed as the leaching proceeds depend on local conditions, particularly soil texture and type of clay present. As a result of the leaching processes there is a tendency for the dispersed clay and organic matter to move down the profile resulting in the formation of a dark, extremely compact layer having a sharply defined upper surface and merging gradually into the subsoil with increasing depth. The darker colour of the compact layer compared with the layer above may be due to its higher clay content since it does not always have a higher content of organic matter. The upper soil layers have a loose porous, laminar structure due to loss of clay and the upper surfaces of this layer may be
paler than the lower, possibly because of silica being deposited on them. The clay pan cracks on
drying into well defined vertical columns having a rounded top and smooth, shiny, well defined
sides. These can be broken into units about 10 cm high and 5 cm across with a flat base. Below
this the column breaks into rather smaller units with flat tops and bottoms which on light
crushing break into angular fragments.

As the leaching of these desalinized soils proceeds, the upper horizons deepen and often become
slightly acidic in reaction and the amorphous silica content increases. As a further stage of
development, it has been suggested that the very characteristic clay pan becomes less
pronounced, possibly because of washing down of sandy material from the A horizon in the
cracks between the structural units.

Table-2 Distinguishing features of saline and sodic soils

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Saline soils</th>
<th>Sodic soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Chemical</td>
<td>a. Dominated by neutral soluble salts consisting of chlorides and sulphates of sodium, calcium and magnesium.</td>
<td>a. Appreciable quantities of neutral soluble salts generally absent. Measurable to appreciable quantities of salts capable of alkaline hydrolysis, e.g. Na_{2}CO_{3}, present.</td>
</tr>
<tr>
<td></td>
<td>b. pH of saturated soil paste is &lt; 8.2.</td>
<td>b. pH of the saturated soil paste &gt; 8.2.</td>
</tr>
<tr>
<td></td>
<td>c. An electrical conductivity of the saturated soil extract of &gt;4 dS m^{-1} at 25 °C is the generally accepted limit above which soils are classed as ‘saline’.</td>
<td>c. An exchangeable sodium percentage (ESP) of 15 or more is the generally accepted limit above which soils are classed as ‘sodic’. Electrical conductivity of the saturated soil extract is generally &lt;4 dS m^{-1} at 25 °C but may be more if appreciable quantities of Na_{2}CO_{3} etc. are present.</td>
</tr>
<tr>
<td></td>
<td>d. There is generally no well-defined relationship between pH of the saturated soil paste and exchangeable sodium percentage (ESP) of the soil or the sodium adsorption ratio (SAR) of the saturation extract.</td>
<td>d. There is a well defined relationship between pH of the saturated soil paste and the exchangeable sodium percentage (ESP) of the soil or the SAR of the saturation extract for an otherwise similar group of soils such that the pH can serve as an approximate index of soil sodicity (alkali) status.</td>
</tr>
<tr>
<td></td>
<td>e. Although Na is generally the dominant soluble cation, the soil solution also contains appreciable quantities of Na_{2}CO_{3} etc.</td>
<td>e. Sodium is the dominant soluble cation. High pH of the soils results in precipitation of soluble Ca and Mg such that their concentration in the soil solution is very low.</td>
</tr>
</tbody>
</table>
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| 2. Physical | a. In the presence of excess neutral soluble salts the clay fraction is flocculated and the soils have a stable structure. | a. Excess exchangeable sodium and high pH result in the dispersion of clay and the soils have an unstable structure. |
| 2. Physical | b. Permeability of soils to water and air and other physical characteristics are generally comparable to normal soils. | b. Permeability of soils to water and air is restricted. Physical properties of the soils become worse with increasing levels of exchangeable sodium/pH. |
| 3. Effect on plant growth | In saline soils plant growth is adversely affected: | In sodic soils plant growth is adversely affected: |
| 3. Effect on plant growth | a. chiefly through the effect of excess salts on the osmotic pressure of soil solution resulting in reduced availability of water; | a. chiefly through the dispersive effect of excess exchangeable sodium resulting in poor physical properties; |
| 3. Effect on plant growth | b. through toxicity of specific ions, e.g. Na, Cl, B, etc.; | b. through the effect of high soil pH on nutritional imbalances including a deficiency of calcium; |
| 3. Effect on plant growth | c. through toxicity of specific ions, e.g. Na, CO₃, Mo, etc. | |
| 4. Soil improvement | Improvement of saline soils essentially requires removal of soluble salts in the root zone through leaching and drainage. Application of amendments may generally not be required. | Improvement of sodic soils essentially requires the replacement of sodium in the soil exchange complex by calcium through use of soil amendments and leaching and drainage of salts resulting from reaction of amendments with exchangeable sodium. |
| 5. Geographic distribution | Saline soils tend to dominate in arid and semi-arid regions. | Sodic soils tend to dominate in semi-arid and sub-humid regions. |
| 6. Ground-water quality | Groundwater in areas dominated by saline soils has generally high electrolyte concentration and a potential salinity hazard. | Groundwater in areas dominated by sodic soils has generally low to medium electrolyte concentration and some of it may have residual sodicity so has a potential sodicity hazard. |
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Mode of salt affected soil formation

Although weathering of rocks and primary minerals is the chief source of all salts, salt-affected soils rarely form through accumulation of salts in situ. The major factors responsible for the formation of two principal categories of salt-affected soils are discussed below:

**Saline soils**

i. **Use of saline groundwater:** When groundwater is the only source available for irrigation, high salinity of the irrigation water can cause a build-up of salts in the root zone (Kanwar, 1961) particularly if the internal drainage of the soils is restricted and leaching, either due to rainfall or applied irrigation, is inadequate.

ii. **Saline seeps,** common in North America, Australia and other countries, are the result of excessive leaching that result from reduced evapo-transpiration after a change in land use from natural forest vegetation to a cereal grain crop or a shift in cropping pattern such as the introduction of a fallow season in a grain farming system. The percolating water passing through saline sediments is intercepted by impermeable horizontal layers and conducted laterally to landscape depressions causing extensive soil salinization.

iii. Salinity problems are also caused by the ingress of sea water through tidal waves, underground aquifers or through wind transport of salt spray. Soluble salts have also been continually exchanged between land and sea - most transfer of salts from the sea taking place through the uplift of marine sediments and exposure on the earth’s surface. For soils of semi-arid regions where rainfed agriculture is practiced, serious salinity problems can arise if the rainfall is only approximately equal to the evapotranspiration and soluble salts are present in the root zone from either marine deposits or other sources.

iv. Salinity problems are most extensive in the irrigated arid and semi-arid areas. In every river basin, prior to the introduction of irrigation, there exists a water balance between the rainfalls on the one hand and stream flow, groundwater level and evaporation and transpiration on the other. This balance is disturbed when large additional quantities of water are artificially spread on the land for agriculture. An important new contribution to groundwater is introduced in the form of seepage from irrigation channels, from irrigation water added over and above the quantities actually utilized for meeting the evapotranspirational needs of crops, and obstructions in the natural drainage brought about by new developments in the area. These new additions to the groundwater will raise the subsoil water level or may form a perched water table.

v. Localized redistribution of salts can often cause salinity problems of a significant magnitude. Soluble salts move from areas of higher to lower elevations, from relatively wet to dry areas, from irrigated fields to adjacent un-irrigated fields, etc. Salts may also accumulate in areas with restricted natural drainage caused by the construction of roads and rail lines or other...
developmental activities. Evaporation of stagnant waters may leave considerable amounts of salts on the soil surface.

**Sodic soils**
The mechanisms responsible for the formation of sodium carbonate in soils which characterize sodic (alkali) soils have been discussed in several standard works. Groundwater containing carbonate and bicarbonate is one of the chief contributing factors in the formation of sodic soils in many regions. According to Bhargava et al. (1980) the alternate wet and dry seasons and the topographic (drainage) conditions appeared to be the contributing factors in the formation of vast areas of sodic soils in the Indo-Gangetic plains of India. During the wet season water containing products of alumino-silicate weathering accumulated in the low lying areas. In the ensuing dry season, as a result of evaporation, the soil solution is concentrated resulting in some precipitation of the divalent cations, causing an increase in the proportion of sodium ions in the soil solution and on the exchange complex with simultaneous increase in pH. This process repeated over years resulted in the formation of sodic soils. Beek and Breemen (1973) pointed out that highly sodic soils could be developed in a closed basin with an excess of evaporation over precipitation if the inflowing water has a positive residual sodicity. Similarly, groundwater containing residual sodicity could result in the formation of sodic soils when the groundwater table is near the surface and contributes substantially to evaporation.

**Management and reclamation of salt affected soils**
1. **Scraping:** Removing the salts that have accumulated on the soil surface by mechanical means has had only a limited success although many farmers have resorted to this procedure. Although this method might temporarily improve crop growth, the ultimate disposal of salts still poses a major problem.

2. **Flushing:** Washing away the surface accumulated salts by flushing water over the surface is sometimes used to desalinize soils having surface salt crusts. Because the amount of salts that can be flushed from a soil is rather small, this method does not have much practical significance.

3. **Leaching:** This is by far the most effective procedure for removing salts from the root zone of soils. Leaching is most often accomplished by ponding fresh water on the soil surface and allowing it to infiltrate. Leaching is effective when the salty drainage water is discharged through subsurface drains that carry the leached salts out of the area under reclamation. Leaching may reduce salinity levels in the absence of artificial drains when there is sufficient natural drainage, i.e. the ponded water drains without raising the water table. Leaching should preferably be done when the soil moisture content is low and the groundwater table is deep. Leaching during the summer months is, as a rule, less effective because large quantities of water are lost by evaporation. The actual choice will however depend on the availability of water and other considerations. In some parts of India for example, leaching is best accomplished during the summer months because this is the time when the water table is deepest and the soil is dry. This
is also the only time when large quantities of fresh water can be diverted for reclamation purposes.

4. Amendments: Whether an amendment (e.g. gypsum) is necessary or not for the reclamation of salt-affected soils is a matter of practical importance. Saline soils are dominated by neutral soluble salts and at high salinities sodium chloride is most often the dominant salt although calcium and magnesium are present in sufficient amounts to meet the plant growth needs. Since sodium chloride is most often the dominant soluble salt, the SAR of the soil solution of saline soils is also high.

5. Drainage: Irrigation is the most effective means of stabilizing agricultural production in areas where the rainfall is either inadequate for meeting the crop requirements or the distribution is erratic. Before the introduction to an area of large quantities of water through irrigation, there exists water balance between the rainfall on the one hand and stream flow, groundwater table, evaporation and transpiration on the other. This balance is seriously disturbed when additional quantities of water are artificially spread on the land to grow agricultural crops, introducing additional factors of groundwater recharge from seepage from canals, distributors and field channels, most of which are unlined, and from the irrigation water let on to the fields over and above the quantities actually utilized by the crops, etc. As a result of these, the groundwater table rises. There are numerous instances throughout the world, where consequent upon the introduction of canal irrigation, the water table has risen considerably within 10 years to less than 2 m. Once the groundwater table is close to the soil surface, due to evaporation from the surface, appreciable movement of the groundwater takes place resulting in the accumulation of salts in the root zone. In general, the critical depth of water table ranges between 1.5 to 3.0 metres depending on soil characteristics, root zone of crops, salt content of groundwater, etc. To ensure a salt-free root zone, evaporation from the groundwater must be prevented thus keeping the groundwater table below the depth that will cause rapid soil salinization. Provision of adequate drainage measures is the only way to control the groundwater table. Subsurface drainage problems may also arise due to the presence, at some soil depth, of a clay barrier, a hardpan, bed rock, or even a subsoil textural change.

i. Surface drainage In surface drainage, ditches are provided so that excess water will run off before it enters the soil. However the water intake rates of soils should be kept as high as possible so that water which could be stored will not be drained off. Field ditches empty into collecting ditches built to follow a natural water course. A natural grade or fall is needed to carry the water away from the area to be drained. The location of areas needing surface drainage can be determined by observing where water is standing on the ground after heavy rain. Field ditches and collection or outlet ditches should be large enough to remove at least 5 cm of water in 24 hours from a level to a gently sloping land. The capacity of a drainage system should be based on the amount and frequency of heavy rains. How quickly water runs into ditches depends on the rate of rainfall, land slope and the condition of the soil surface including the plant cover. The
area that a ditch can satisfactorily drain depends on how quickly water runs into the ditch, the size of the ditch, its grade or slope and its irregularity. The latter is measured by the roughness and the contents of debris and growing vegetation in the ditch. In relatively level areas (slope < 0.2%) a collecting ditch may be installed along one side and shallow v-shaped field ditches constructed to discharge into this collecting ditch. Field ditches used to discharge water into collecting ditches should be laid out parallel to each other 20 to 60 m apart. They should be 30 to 45 cm deep depending upon the depth of the collecting ditch. Care should be taken to avoid sharp curves in the ditches to lessen erosion of the banks.

ii. Subsurface drainage
If the natural subsurface drainage is insufficient to carry the excess water and dissolved salts away from an area without the groundwater table rising to a point where root aeration is affected adversely and the groundwater contributes appreciably to soil salinization, it may be necessary to install an artificial drainage system for the control of the groundwater table at a specified safe depth. The principal types of drainage systems may consist of horizontal relief drains such as open ditches, buried tiles or perforated pipes or in some cases pumped drainage wells.

Crops in saline soils
Crop plants differ a great deal in their ability to survive and yield satisfactorily when grown in saline soils. Information on the relative tolerance of crops to a saline soil environment is of practical importance in planning cropping schedules for optimum returns. There are situations where farmers have to live with salinity problems, for example, in areas having saline water as the only source of water for irrigation. In other situations where good quality water is available for reclamation of saline soils, it is often helpful to grow crops simultaneously with reclamation efforts to make reclamation economic.

Rice in saline soils
Although rice is not tolerant to excess salinity, it is a crop superior in saline soils and, in fact, is preferred over other tolerant crops during the initial stages of reclamation of many saline soils. This is chiefly due to the system of lowland rice culture that is advantageous to the crop rather than to the tolerance of the crop to soil salinity. The system of lowland rice culture involving maintenance of standing water almost throughout the growing season brings about a significant reduction in the root zone salinity by leaching and dilution of the salts. Thus the crop is at no stage subjected to the salinity stress that might be indicated by the initial soil analysis. Rice is an important crop in many coastal regions and is grown during the rainy season. Although initially the soil salinity may be high, after one or two rains salinity is reduced in the upper few centimeters enabling planting of seedlings grown in a relatively good soil. Salinity is usually a greater constraint in the dry season when the evaporative demand is high and supply of good quality water restricted. Under these conditions when groundwater of high salinity must be used, salinity becomes a major constraint to obtaining satisfactory crop yields. Reclamation requires that the soluble salts from the profile are leached and drained through a suitable system of drainage, but good quality water is often a major constraint in arid regions. Therefore, leaching alone for prolonged periods is not justifiable and so a rice crop is conveniently grown during
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reclamation. Rice gives satisfactory yields even when the electrical conductivity of the saturated soil extract is 20 to 25 dSm\(^{-1}\) in the upper layers. Even on soils with low infiltration rates the accumulated depth of water percolating through the soil profile in one rice season may be 100 to 200 mm. Although leaching under continuously ponded conditions has the disadvantage of being less efficient for salt leaching compared to intermittent irrigation, the benefit of simultaneous crop production makes rice an ideal crop during reclamation of saline soils.

**Reclamation and management of sodic soils**

1. Amendments: Basically, reclamation or improvement of sodic soils requires the removal of part or most of the exchangeable sodium and its replacement by the more favourable calcium ions in the root zone. This can be accomplished in many ways, the best dictated by local conditions, available resources and the kind of crops to be grown on the reclaimed soils. If the cultivator can spend very little for reclamation and the amendments are expensive or not available, and he is willing to wait many years before he can get good crop yields, soil can still be reclaimed but at a slow rate by long-continued irrigated cropping, ideally including a rice crop and sodic tolerant crops in the cropping sequence, along with the incorporation of organic residues and/or farmyard manure. For reasonably quick results cropping must be preceded by the application of chemical soil amendments followed by leaching for removal of salts derived from the reaction of the amendment with the sodic soil. Soil amendments are materials, such as gypsum or calcium chloride, that directly supply soluble calcium for the replacement of exchangeable sodium, or other substances, such as sulphuric acid and sulphur, that indirectly through chemical or biological action, make the relatively insoluble calcium carbonate commonly found in sodic soils, available for replacement of sodium. Organic matter (i.e. straw, farm and green manures), decomposition and plant root action also help dissolve the calcium compounds found in most soils, thus promoting reclamation but this is relatively a slow process. The kind and quantity of a chemical amendment to be used for replacement of exchangeable sodium in the soils depend on the soil characteristics including the extent of soil deterioration, desired level of soil improvement including crops intended to be grown and economic considerations.

**Kind of amendments**

Chemical amendments for sodic soil reclamation can be broadly grouped into three categories:

a. Soluble calcium salts, e.g. gypsum, calcium chloride.

b. Acids or acid forming substances, e.g. sulphuric acid, iron sulphate, aluminium sulphate, lime-sulphur, sulphur, pyrite, etc.

c. Calcium salts of low solubility, e.g. ground limestone.

The suitability of one or another amendment for sodic soil reclamation will largely depend on the nature of the soil and cost considerations. Ground limestone, CaCO\(_3\), is an effective amendment only in soils having pH below about 7.0 because its solubility rapidly decreases as the soil pH increases. It is apparent that the effectiveness of limestone as an amendment is markedly decreased at pH values above 7.0. Some soils that contain excess exchangeable sodium also contain appreciable quantities of exchangeable hydrogen and therefore have an acidic reaction, e.g. degraded sodic soils. Lime reacts in such soils according to the reaction:
Na, H - clay micelle + CaCO₃ Û Ca - clay micelle + NaHCO₃

However, lime is not an effective amendment for most sodic soils as their pH is always high. In fact, sodic soils contain measurable to appreciable quantities of sodium carbonate which imparts to these soils a high pH, always more than 8.2 when measured on a saturated soil paste and up to 10.8 or so when appreciable quantities of free sodium carbonate are present. In such soils only amendments comprising soluble calcium salts or acids or acid-forming substances are beneficial.

**Gypsum**

Gypsum is chemically CaSO₄.2H₂O and is a white mineral that occurs extensively in natural deposits. It must be ground before it is applied to the soil. Gypsum is soluble in water to the extent of about one-fourth of 1 percent and is, therefore, a direct source of soluble calcium. Gypsum reacts with both the Na₂CO₃ and the adsorbed sodium as follows:

\[ \text{Na}_2\text{CO}_3 + \text{CaSO}_4 \rightleftharpoons \text{CaSO}_3 + \text{Na}_2\text{SO}_4 \text{ (leachable)} \]

\[ \text{Na}_n\text{clay} \text{ micelle} + \text{CaSO}_4 \rightleftharpoons \text{clay} \text{ micelle} + \text{Na}_2\text{SO}_4 \text{ (leachable)} \]

**Calcium chloride:** Calcium chloride is chemically CaCl₂ 2H₂O. It is a highly soluble salt which supplies soluble calcium directly. Its reactions in sodic soil are similar to those of gypsum:

\[ \text{Na}_2\text{CO}_3 + \text{CaCl}_2 \rightleftharpoons \text{CaCO}_3 + 2 \text{NaCl} \text{ (leachable)} \]

\[ \text{Na}_n\text{clay} \text{ micelle} + \text{CaCl}_2 \rightleftharpoons \text{Ca} \text{clay micelle} + 2\text{NaCl} \text{ (leachable)} \]

**Sulphuric acid:** Sulphuric acid is chemically H₂SO₄. It is an oily corrosive liquid and is usually about 95 percent pure. Upon application to soils containing calcium carbonate it immediately reacts to form calcium sulphate and thus provides soluble calcium indirectly. Chemical reactions involved are:

\[ \text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 \rightleftharpoons \text{CO}_2 + \text{H}_2\text{O} + \text{Na}_2\text{SO}_4 \text{ (leachable)} \]

\[ \text{CaCO}_3 + \text{H}_2\text{SO}_4 \rightleftharpoons \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2 \]

\[ \text{Na}_n\text{clay} \text{ micelle} + \text{CaSO}_4 \rightleftharpoons \text{Ca} \text{clay micelle} + \text{Na}_2\text{SO}_4 \text{ (leachable)} \]

**Iron sulphate and aluminiumsulphate (alum):** Chemically these compounds are FeSO₄.7H₂O and Al₂(SO₄)₃.18H₂O respectively. Both these solid granular materials usually have a high degree of purity and are soluble in water. When applied to soils, these compounds dissolve in soil water and hydrolyse to form sulphuric acid, which in turn supplies soluble calcium through its reaction with lime present in sodic soils. Chemical reactions involved are:

\[ \text{FeSO}_4 + 2\text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{SO}_4 + \text{Fe(OH)}_2 \]
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\[ \text{H}_2\text{SO}_4 + \text{CaCO}_3 \rightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2 \]

\[ \frac{\text{Na}}{\text{Na}_2} \text{clay micelle} + \text{CaSO}_4 \rightleftharpoons \text{Ca} \text{clay micelle} + \text{Na}_2\text{SO}_4 \text{ (leachable)} \]

Similar reactions are responsible for the improvement of sodic soils when aluminum sulphate is used as an amendment.

**Sulphur (S):** Sulphur is a yellow powder ranging in purity from 50 percent to more than 99 percent. It is not soluble in water and does not supply calcium directly for replacement of adsorbed sodium. When applied for sodic soil reclamation, sulphur has to undergo oxidation to form sulphuric acid which in turn reacts with lime present in the soil to form soluble calcium in the form of calcium sulphate:

\[ 2 \text{S} + 3 \text{O}_2 \rightarrow 2 \text{SO}_3 \text{ (microbiological oxidation)} \]

\[ \text{SO}_3 + \text{H}_2\text{O} = \text{H}_2\text{SO}_4 \]

\[ \text{H}_2\text{SO}_4 + \text{CaCO}_3 \rightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2 \]

\[ \frac{\text{Na}}{\text{Na}_2} \text{clay micelle} + \text{CaSO}_4 \rightleftharpoons \text{Ca} \text{clay micelle} + \text{Na}_2\text{SO}_4 \text{ (leachable)} \]

**Pyrite:** Pyrite (FeS\(_2\)) is another material that has been suggested as a possible amendment for sodic soil reclamation. Reactions leading to oxidation of pyrite are complex and appear to consist of chemical as well as biological processes.

\[ 2 \text{FeS}_2 + 2 \text{H}_2\text{O} + 7 \text{O}_2 \rightarrow 2 \text{FeSO}_4 + 2 \text{H}_2\text{SO}_4 \]

This reaction is then followed by the bacterial oxidation of iron II sulphate, a reaction normally carried out by *Thiobacillus ferrooxidans*,

\[ 4 \text{FeSO}_4 + \text{O}_2 + 2 \text{H}_2\text{SO}_4 \rightarrow 2 \text{Fe}_2(\text{SO}_4)_3 + 2 \text{H}_2\text{O} \]

Subsequently iron III sulphate (ferric) is reduced and pyrite is oxidized by what appears to be a strictly chemical reaction.

\[ \text{Fe}_2(\text{SO}_4)_3 + \text{FeS}_2 \rightarrow 3 \text{FeSO}_4 + 2 \text{S} \]

Elemental sulphur so produced may then be oxidized by *T. thiooxidans* and the acidity generated favours the continuation of the process.

\[ 2 \text{S} + 3 \text{O}_2 + 2 \text{H}_2\text{O} \rightarrow 2 \text{H}_2\text{SO}_4 \]

Summary: \[ 4 \text{FeS}_2 + 2 \text{H}_2\text{O} + 15 \text{O}_2 \rightarrow 2 \text{Fe}_2(\text{SO}_4)_3 + 2 \text{H}_2\text{SO}_4 \]
Others: In some localities cheap acidic industrial wastes may be available which can be profitably used for sodic soil improvement. Press mud, a waste product from sugar factories, is one such material commonly used for soil improvement. Press mud contains either lime or some gypsum depending on whether the sugar factory is adopting carbonation or a sulphitation process for the clarification of juice. It also contains variable quantities of organic matter.

REFERENCES

- CSSIR. Central soil salinity research institute, Karnal, Haryana.
BIOFORTIFICATION: A NOVEL APPROACH TO REDUCE MALNUTRITION

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INTRODUCTION

Hunger is acknowledged to impose a heavy burden on humankind with severe negative health consequences. Micronutrient malnutrition, or “hidden hunger”, is an even more widespread problem, to which economic development and income growth alone are not expected to provide a solution any time soon. Existing micronutrient interventions like pharmaceutical supplementation or industrial fortification have their limitations and can be complemented by a new approach: breeding food crops for higher micronutrient densities.

Despite the successes of the Green Revolution and continued efforts to fight poverty, hunger remains widespread, with an estimated 800m undernourished people in the developing world (United Nations SCN). An estimated 3.5 billion people in developing countries are affected by iron deficiency (ID), 2.2 billion people suffer from iodine deficiency and over 250 million children are affected by vitamin A deficiency. Iron deficiency is the single largest micronutrient deficiency in India, about 50% of women are anaemic, as are 74% of children. Zinc and Fe deficiencies are a growing public health and socioeconomic issue, particularly in the developing world (Welch and Graham 2004). Recent reports indicate that nearly 500,000 children under 5 years of age die annually because of Zn and Fe deficiencies (Black \textit{et al.}, 2008). Zinc and Fe deficiencies together with vitamin A deficiency have been identified as the top priority global issue to be addressed to achieve a rapid and significant return for humanity and global stability (www.copenhagenconsensus.com). Low dietary intake of Fe and Zn appears to be the major reason for the widespread prevalence of Fe and Zn deficiencies in human populations. In countries with a high incidence of micronutrient deficiencies, cereal-based foods represent the largest proportion of the daily diet (Cakmak, 2008).
Thus malnutrition is very serious issue which needs to be solved to save lives of people and to provide them a healthy life. Malnutrition can be solved mainly by these four methods:

1. **Supplementation**- the addition of an element to the diet to make up for an insufficiency (Vitamin capsules).
2. **Food fortification**- the addition of an ingredient to food to increase the concentration of a particular element (Iodised salt, Vitamin A and D in margarine).
3. **Dietary diversification**- By eating a variety of foods to achieve various micronutrients. “Probably as many as 30 biologically distinct types of foods, with the emphasis on plant foods, are required for healthy diets”
4. **Biofortification**- Biofortification is defined as breeding of food crops that are rich in bio-available micronutrients (CGIAR, 2003).

Among the methods above described, biofortification is the very suitable method for solving the malnutrition problem because all the other method requires much investment which poor people cannot afford at all. Thus the strategy is targeted at those who cannot afford a diet adequate in fruits, vegetables and meats, which are better sources of micronutrients. One-time investment this strategy can produce a constant stream of future benefits to consumers of these crops.

Biofortification employ the “disability adjusted life years” (DALYs) framework, which gained currency as metric for measuring health outcomes. Since the 1990s, with the “World Development Report” (World Bank) and with “The Global Burden of Disease” study (GBD) by Murray and Lopez, DALYs have become increasingly popular to measure health. Quantifying the burden of vitamin A deficiency in the Philippines, Zimmermann and Qaim were the first to employ this framework to analyse the benefits of biofortification. The crucial element in this measure is the weighting of years of life lived with disabilities resulting from a specific disease; these severity weights (or “disability weights”) can be in the range between 0 and 1, with 0 (21)
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representing perfect health and 1 representing a health status equal to death. The DALYs measure of the total burden of a disease is obtained as the sum of “years of life lost” (YLL) due to cause-specific mortality and the sum of “years lived with disability” (YLD), the latter of which are weighted. That is,

1. **Burden of disease = DALYs lost = YLL + YLD**, where
2. **YLL = f (size of target group, mortality rate of disease, discount rate)**, and
3. **YLD = f (size of target group, incidence rate, disability weight, discount rate)**.

Further the biofortification can be useful for-

✓ **Burden of iron deficiency**: 4 million DALYs lost, iron-rich wheat may save 20-60%.
✓ **Burden of zinc deficiency**: 2.8 million DALYs lost, zinc-rich wheat may save 20-50%.
✓ **Burden of vitamin A deficiency**: 2.3 million DALYs lost, Golden Rice may save 10-60%.

**Programmes which support biofortification:**

There are various international programmes are going on which are playing an important role in biofortification of various crops. Some among them are as follows-

- HarvestPlus (HarvestPlus, 2009)
- The Golden Rice Project (GR, 2009)
- African Biofortified Sorghum (ABS, 2009)
- BioCassava Plus (BCP, 2009)
- Biofortification of Bananas (2009)
- BAGELS (2009)
- HarvestZinc (2009)

Among all these programmes, HarvestPlus is working as a major programmes in various countries including India for biofortification.

**HarvestPlus:**

HarvestPlus is a global alliance of institutions and scientists seeking to improve human nutrition by breeding new varieties of staple food crops consumed by the poor that have higher levels of micronutrients, through a process called biofortification. It is an initiative of the Consultative Group on International Agricultural Research HarvestPlus (CGIAR). It is coordinated by the International Centre for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI). 85% of Harvest Plus resources are for conventional breeding.

**Stages of Biofortification through Harvest Plus:**

- **Discovery**
  1. Identify target population
  2. Set nutrient target levels
  3. Screen germplasm and gene

- **Development**
  4. Breed biofortified crops
  5. Test performance of new crop varieties
  6. Measure nutrient retention in crops/food

(22)
7. Evaluate nutrient absorption and impact

- **Dissemination**
  8. Develop strategies to disseminate seeds
  9. Promote marketing & consumption of biofortified food

- **Outcomes**
  10. Improve nutritional status of target population

**Types of Biofortification:**

Now we can use biofortification also by different methods on the basis of that it can be classified into three types-

1. **Agronomic biofortification:** A balanced NPK dose along with balanced Zn accelerates the process of cell division and elongation, photosynthesis processes, respiration which finally reflected in increased grain and straw yields as well as increased harvest index. Karam *et al.*, 2014 reported that the application of 5, 10 and 20 kg Zn ha⁻¹ significantly increased the Zn concentration in root, stem, leaves and earhead of wheat over NPK fertilization alone at different growth stages of wheat. The most effective method for increasing Zn in grain was the soil+foliar application method that resulted in about 3.5-fold increase in the grain Zn concentration. The highest increase in grain yield was obtained with soil, soil+foliar and seed+foliar application (Yilmaz *et al.*, 1997).

Phattarakul *et al.*, 2012 reported during their study on evaluation of the effect of soil and/or foliar Zn fertilizer application on grain yield and grain Zn concentration of rice that Zn application increased grain yield by about 5%. Grain Zn concentrations were, however, more effectively increased by Zn fertilization, especially with foliar Zn applications. On average, Zn concentration in brown rice (whole caryopsis with husk removed) was increased by 25% and 32% by foliar and foliar + soil, Zn applications in China and India. Foliar Zn fertilization was an effective approach to promote grain Zn concentration and Zn bioavailability, especially, in case of Zn-AA and ZnSO₄. On average, Zn-AA and ZnSO₄ increased.

Zn concentration in polished rice up to 24.04% and 22.47%, respectively and ZnSO₄ increased Zn bioavailability in polished rice up to 68.37% and 64.43%, respectively. Therefore, it’s believed that foliar application of suitable Zn form is a feasible approach to improve the bioavailable Zn status in polished rice (Yanyan Wei *et al.*, 2012).

2. **Genetic Biofortification:** In an effort coordinated by the HarvestPlus project, CGIAR (The Consultative Group on International Agricultural Research) Centers are taking a leading role in breeding for increasing concentration and bioavailable levels of Zn and Fe in seeds of major stable food crops (Bouis, 2003; Pfeiffer and McClafferty, 2007). Plant breeding (e.g. genetic biofortification) approach to minimize the extent of Zn deficiency is thought to be cost-effective, easily applicable and affordable in the target population. A breeding program aiming at development of new genotype with high Zn concentration first requires existence of useful genetic variation for Zn accumulation in grain. However, as indicated above, cultivated wheat contain very low level of Zn and shows a narrow genetic variation for Zn. Compared to cultivated wheats, wild and primitive wheats represent a better and more
promising genetic resource for high Zn concentrations. Among wild wheats tested so far, the collections of wild emmer wheat, Triticum turgidum ssp. dicoccoides, showed impressive genetic variation and the highest concentrations of Zn (14 to 190 mg Zn kg−1, Cakmak et al. 2004). Very recently, new wild emmer wheat accessions have been identified showing simultaneously both very high concentrations of Zn (up to 139 mg kg−1), Fe (up to 88 mg kg−1) and protein (up to 380 g kg−1) in seeds and high tolerance to drought stress and Zn deficiency in soil (Peleg et al. 2008). In addition, synthetic wheats derived from Aegilops tauschii have also a high genetic potential for increasing grain Zn concentration of cultivated wheat. A large genetic variation for grain Zn has also been shown in different germplasm of rice and maize and this variation is being exploited in breeding programs (Graham et al., 1999). White and Broadley (2005) published a comprehensive review on natural variation of micronutrients in different crop species and reported recent advances in development of new genotype with high level of micronutrients, including Zn. Little information is, however, available about the genetic control and molecular physiological mechanisms contributing to high accumulation of Zn and other micronutrients in grain of different genetic materials. Studies with the substitution lines of Triticum dicoccoides showed that the dicoccoides chromosome 6B is the most relevant chromosome carrying the genes determining high levels of Zn in grain (Cakmak et al., 2004). In studies with different recombinant substitution lines derived from Triticum dicoccoides a locus Gpc-B1 has been identified on the short arm of the chromosome 6B that affects both protein and Zn concentrations (Fahima et al., 2006; Distelfeld et al., 2007). The enhancing role of Gpc-B1 on grain Zn and protein concentrations has been shown consistently in five different environments, suggesting that the effect of GxE on the Zn and protein levels of the lines carrying the Gpc-B1 allele is small (Distelfeld et al. 2007). These results indicate that the genes responsible for high levels of Zn and protein are, most probably, closely related, and breeding for high protein in grain may result in simultaneously high grain Zn. Very high positive correlations reported between grain Zn and protein (Peterson et al., 1986; Feil and Fossati, 1995; Distelfeld et al., 2007) support the idea that the genetic factors affecting grain Zn and protein concentrations are possibly co-segregated. Breeding efforts are, now, ongoing to introgress the Gpc-B1 locus into genetic background of high yielding elite cultivars.

Advantages of Genetic Biofortification:

1. It is quicker, cheaper method.
2. It is less controversial than genetically engineered foods.
3. It is most common method of improvement of crops in nutritional value.
4. Transgenic Biofortification: Transgenic approaches could be a further option in improving food crops with Zn. Currently, impressive progress is being made in developing transgenic plant genotypes with increased concentrations of Zn and Fe. Evidence is available showing a potential role of ZIP family Fe and Zn transporter proteins in improving micronutrient density in grain. These proteins are involved in uptake and transport of cationic micronutrients in cells. In most cases, the genes encoding the Fe and Zn transporter proteins are expressed in response to Fe and
Zn deficiencies, respectively. However, the role of these transporter proteins in genotypic variation for Plant Soil (2008) 302:1–17 5 Zn deficiency tolerance or grain Zn accumulation is not clear. Expression of the genes encoding a Zn transporter protein from Arabidopsis thaliana in roots of a barley genotype resulted in an increase in grain Zn concentration. Several reports have investigated the role of ferritin protein in seed accumulation of Fe and Zn. Ferritin is a major Fe protein existing in most living organisms. It was reported that overexpression of soybean ferritin genes in rice was effective in increasing both Fe and Zn concentrations of seeds. Transforming rice with ferritin gene from soybean increased grain Fe concentrations. Several reports have investigated the role of ferritin protein in seed accumulation of Fe and Zn. Ferritin is a major Fe protein existing in most living organisms. It was reported that overexpression of soybean ferritin genes in rice was effective in increasing both Fe and Zn concentrations of seeds. Transforming rice with ferritin gene from soybean increased grain Fe concentrations. As in rice, overexpression of the ferritin gene was also effective in improving seed Fe concentration of transgenic maize plants expressing ferritin gene from soybean. Very recently, it has been shown that the Gpc-B1 locus from Triticum dicoccoides encodes a NAC transcription factor (NAM-B1) that increases grain Zn and Fe concentrations, possibly by stimulating leaf senescence and thus remobilization of Zn and Fe from flag leaves into seeds (Uauy et al., 2006). Reduced expression of the NAM genes delayed senescence and reduced Zn and Fe concentrations. However, in all these studies dealing with overexpression of ferritin, Zn transporter protein and NAM genes (Uauy et al., 2006), no data on grain yield per plant or per spike were presented, making it impossible to assess any potential dilution or concentration effects on the reported changes in grain Fe or Zn concentrations. Genotypic variation for grain yield or the number of seeds per plant may cause significant “dilution” or “concentration” effects on the reported amount of micronutrients, despite a similar 1000 kernel weight. Although it is a powerful and sustainable strategy, breeding approach has some limitations: it is a longterm process requiring variety of breeding activities and huge resources. In addition, it is uncertain whether this strategy will effectively work after all the long-term efforts. The breeding steps include at least (1) identification of a useful genetic variation and the most promising parents, (2) long-term crossing and back-crossing activities, (3) stability of the target traits (e.g. high grain Zn concentration) across the different environment that feature huge variation in soil and climatic conditions, and finally (4) adaptation of the newly developed biofortified genotypes over a range of crop and soil management practices applied in the target regions or countries. The acceptance of biofortified crops by producers is a further issue that needs a special attention. Most importantly, newly developed genotypes should be able to extract sufficiently large amounts of Zn from potentially Zn-deficient soils and accumulate it in whole grain at sufficient levels for human nutrition (e.g. up to 40–60 mg kg−1). As discussed below in detail, the soils widespread in major cereal-growing regions have several adverse soil chemical factors (i.e. high pH value and low soil moisture and organic matter) that could potentially diminish the expression of high grain Zn trait and limit the capacity of newly developed (biofortified) cultivars to absorb adequate amount of Zn from soils to contribute to daily Zn requirement of human beings.

Advantages of Transgenic Biofortification:
1. Helps to increase the micronutrient levels in staple crops.
2. It can help to prevent and reduce the micronutrient deficiencies.
3. Transgenic material in the form of seeds and fruits can be easily stored and transported from one place to another (without fear for its degradation or damage).
4. Transgenic plants capable for producing several different products can be created at any time by crossing the plants that produce different products.

Cereal crops are inherently very low in grain Zn and Fe concentrations and growing them on potentially Zn and Fe-deficient soil further reduces Fe and Zn concentrations in grain (Cakmak et al., 2010). Thus, biofortification of cereal crops with Zn and Fe is a high-priority global issue. HarvestPlus is the major international consortium to develop new plant genotypes with high concentration of micronutrients by applying classical and modern breeding tool (i.e. genetic biofortification). Cereal consumption in India is high, it averaged 12.7 kg per capita per month (pcpm) in rural areas, and 10.4 kg pcpm in urban areas. Rice and wheat constitute the bulk of the cereals consumed: in rural areas rice consumption averaged 6.8 kg pcpm and that of wheat averaged 4.5 kg pcpm. That’s why the focus is on rice and wheat:

Achievements in various crops:
Vitamin A Cassava- Nigeria, Iron Bean- Rwanda, Orange Sweet Potato- Africa
Vitamin A Maize- Zambia, Iron Pearlmillet- India, Zinc Rice- Bangladesh, Zinc Wheat- India

Biofortification of Rice:
Iron Biofortification
In the Fe-Rice Biofortification process - Three genes were introduced into the Japonica rice variety:
  a) Ferritin – enhances iron storage in grains and was expressed under an endosperm specific promoter
  b) Nicotianamine synthase– was expressed under a constitutive promoter & produces nicotinamine which chelates iron temporarily facilitating its transport in plants
  c) Phytase – degrades phytate

Zn-Rice Biofortification process;
Three (3) genes of the OSNAS family were introduced into Japonica rice cultivar Nipponbarp
1 Nicotianamine (NA)
2. OSNAS 2
3. OSNAS 3

Vitamin A (Golden Rice)
Discovered by Pro. Ingo potrykus and Dr. Peter Bayer. He used the following genes for golden rice:
  1. Phytoene synthase (psy) – daffodil (Narcissus pseudonarcissus)
  2. Lycopene B - cyclase (crt) – daffodil (Narcissus pseudonarcissus)
  3. Phytoene desaturase – bacterium (Erwinia uredevora)
They successfully made production of Golden rice 1 (GR1) and Golden rice 2 (GR2)
  GR1- yield of 1.6μg provitamin A/g in endosperm
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- GR2- higher yield of 31μg/g provitamin A in endosperm by replacement of psy gene from daffodil with a psy gene from maize.

REFERENCES

INTRODUCTION
The future of our nation and the prosperity of our people depend on the health and Happiness. Assessment of nutritional status of community is one of the first steps in the formulation of any public health strategy to combat malnutrition. Human body reflects changes in morphological variation due to inappropriate food intake or malnutrition. Nutritional assessment involves evaluation by anthropometric, biochemical, clinical and dietary methods. Techniques for measuring body composition of fat and lean body mass include anthropometry and bioelectric impedance analysis. Abnormalities in the distribution of fat and lean tissue may also compromise the interpretation of some anthropometric measures. To assess the nutritional status of an individual or population, anthropometry is widely recognized as one of the useful techniques because it is highly sensitive to detect under nutrition, while much of the global adulthood stunting and wasting are the result of deficiencies in energy and protein which is mainly assessed by dietary intake at individual or household level. Assessment of the nutritional status aids in assessing the prevalence of nutritional disorders, planning corrective measures, and simultaneously evaluating the effectiveness of the implemented strategies.

Chapter Content
1. Introduction
   2. Assessment of nutritional status
   3. Nutritional Status Methods
      I. Direct Method
         a) Anthropometry
         b) Clinical examination
         c) Biophysical or radiological examination
         d) Functional assessment
         e) Laboratory and biochemical estimation
      II. Indirect Method
         a) Dietary Survey
         b) Vital Health Statistics
         (c) Subjective Global Assessment (SGA)

1. INTRODUCTION
Nutritional assessment is the systematic process of collecting and interpreting information in order to make decisions about the nature and cause of nutrition related health issues that affect an
individual (British Dietetic Association (BDA), 2012). Nutritional health is maintained by a state of equilibrium in which nutrient intake and requirements balanced. Malnutrition occurs when nutrient intake is less than requirements. Malnutrition leads to a succession of metabolic abnormalities, physiological change, reduced organ and tissue function and loss of body mass. The nutritional assessment process identifies patients who are at nutritional risk. Adults who are nutritionally at risk are those who have malnutrition or the potential for developing malnutrition. Anthropometric measurements of body size and composition, including height, weight, body circumference measurements are valuable in evaluating protein energy malnutrition. Biochemical tests are generally used to determine internal chemistry. The most common and useful biochemical techniques in evaluating malnutrition are measurements of hemoglobin, blood cell count, nitrogen balance and creatinine excretion in blood, urine and feces that indicates infection or diseases. Clinical assessment is change in skin color and health, hair texture, fingernail, shape etc. Diet history helps to evaluate diet for nutrients (protein, fat, calcium, iron etc.) or food intake (no. of fruits and vegetables). The nutritional status of an individual is usually a result of multiple factors that interact with each other at different levels. The eating pattern of an individual is a crucial factor that dictates the occurrence of a disease, especially some chronic conditions such as coronary heart disease, hypertension, stroke, diabetes mellitus, and cancer. In addition, adverse outcomes such as low birth weight, malnutrition, disability, poor quality of life, and mortality are also related to poor eating pattern. Recognizing the role of diet at onset of many diseases, and assessing nutritional status of an individual, family and community are important for public health.

2. ASSESSMENT OF NUTRITIONALStatus

Nutritional health is maintained by a state equilibrium in which nutrient intake or requirements balance. Assessment of nutritional status of community is one of the first steps in the formulation of any public health strategy to combat malnutrition. Malnutrition occurs when net nutrient intake is less than requirements. Malnutrition leads to a succession of metabolic abnormalities, physiological changes, reduced organ and tissue function and loss of body mass. The principle aim of such an assessment is to determine the type, magnitude and distribution of malnutrition in different geographic areas to identify at risk group and to determine the contributory factors.

3. NUTRITIONAL STATUS CAN BE ASSESSED BY THE FOLLOWING METHODS

I. Direct Method
   a) Anthropometry
   b) Clinical examination
   c) Biophysical or radiological examination
   d) Functional assessment
   e) Laboratory and biochemical estimation

II. Indirect Method
   a) Dietary Survey
   b) Vital Health Statistics

a) Anthropometric Assessment
Anthropometric measurements mean body measurements and provide information on body muscles and fat reserves. Human body reflects changes in morphological variation due to inappropriate food intake or malnutrition. Information on these aspects is therefore important and has practical application. A variety of anthropometric measurements can be made either covering the whole body or parts of the body. Anthropometric measurements can be taken for cross sectional or longitudinal studies. In anthropometric measurements, there are no permanent standards as there is no uniformity of growth in subsequent generation. The younger generation is taller and heavier than the older generation. Local standards need to be developed for various ethnic groups periodically.

i) Body Weight
Body weight is the most widely used and the sensitive and simplest reproducible anthropometric measurements for the evaluation of nutritional status of young children. It indicates the body mass and is a composite of all body constituents like water, minerals, fat, protein and bone. It reflects more recent nutrition than does height. Body weight should be obtained using an electronic scale or a balance beam scale. Electronic scales are portable, faster, lighter and easier to use. Spring type bathroom scales are not recommended because of less accuracy. Infants should be weighed on a pan-type pediatric electronic or balance beam scale. While weighing, scale should be placed on a flat and hard surface and should be calibrated to zero. Respondents should be weighed under basal condition with minimum clothing and without shoes. The individual should not lean against or hold anything however he/she should stand in the middle of the scale, feet slight apart and to remain still the weight stabilized in the scale. Record the weight to the nearest 0.1 Kg.

ii) Height
The height of an individual is influenced both by genetic and environmental factors. The maximum growth potential is decided by hereditary factors, while the environmental factors, the most important being nutrition and morbidity, determine the extent of exploitation of that genetic potential. Height is affected only by long term nutritional deprivation; it is considered an index of chronic or long duration malnutrition. In children below the age of two years who can’t stand properly, recumbent length (crown-heel length) should be measured with infantometer. Legs need to be held straight and firm with the feet touching the sliding board. In order children and adults, heights are measured with a vertical measuring rod using anthropometer and standiometer. The subject should stand erect looking straight on a leveled surface with heels together and toes apart, without shoes. Height should be read to the nearest ¼” or 0.5 cm.

iii) Mid-Upper Arm Circumferences (MUAC)
Mid-Upper Arm Circumferences is recognized to indicate the status of muscle development. It is useful not only in identifying malnutrition but also in deterring the mortality risk in children. On the left hand, the mid-point between the tip of the acromion of scapula and tip of the olecranon
of the fore-arm bone, ulna should be located with the arm flexed at the elbow and should be
marker pen. Fibre glass tape should be used and the reading should be taken to the nearest
millimeter. MUAC can also be measured using Shakir tape, quack stick or bangle test.

v) **Head and Chest Circumference:** Head size relates mainly to the size of brain which increases quite rapidly during infancy. Head circumference at birth is 35 cm. It increases by the 1 cm per month up to 6 months. Later it increased by 4 cm totally in the next 6 months. By 1 year it should be 45 cm. By 2 years the head circumference is 47 cm, by three years 48 cm, by 5 years 50 cm and by 18 years 55 cm. Head circumference and chest circumference ratio is equal at one year. If head circumference is more than chest circumference, it indicates malnutrition. The chest in a normally nourished child grows faster than head during the second and third year of life. As a result, the chest circumference overtakes head circumference by about one year age. In protein energy malnutrition due to poor growth of chest, the head circumference may remain to be higher than the chest even at the age two and half to three years. Flexible fibre glass tape is used. The chest circumference is taken at the nipple level preferably in mid inspiration. The head circumference is measured passing the tape round the head over the supra-orbital ridges of the frontal bone in front and the most protruding point of the occiput on the back of the head.

v) **Skin-fold Thickness Measurements**

Body fat is located both internally and subcutaneously. If one assumes a constant relationship between subcutaneous fat and total body fat, then total body fat can be estimated by measuring the amount of subcutaneous adipose tissue. Subcutaneous tissue can be estimated by measuring the thickness of the subcutaneous fat layer at different sites of the body using a skin-fold caliper.
The most often measured skin-folds for the assessment of the total body fat are skin-folds on the arm biceps and triceps, under the scapula (sub scapular) and above the iliac crest (suprailiac). The averages of skinfold measurement are normally used to reduce error.

**vi) Fat Fold at Triceps**
The measurements provide an estimate of the body’s fat reserves. By using skin-fold calipers thickness of the fat layer is measured. This is measured by picking the skin fold between the thumb and forefinger on the dorsal side at the same mid point where mid upper arm circumference on the right arm. Fat fold at triceps is the least error-prone.

**vii) Fat Fold and Sub- scapula**
The fat fold is measured just below and lateral to the angle of the left scapula by picking it up with the thumb and forefinger in a line running approximately 45° to the spine, into spine, in the natural line of skin cleavage. The calipers used should have a standard contact surface (pinch area) of 20-40 mm and an accuracy of 0.1 mm. Some of the standard calipers used are Harpender, Lange and Best. Una caliper is used in India.

**Assessment of Children with Indices:**
Weight, height and arm circumferences are considered the most sensitive parameters for assessing nutritional status of less than five. Several methods have been suggested for the classification of nutritional status based on these measurements.

**Weight for Age:** Weight for age is known as the indicator of underweight. The most widely used classification of nutritional status as per weight for age is given in Table 1 to 4.

<table>
<thead>
<tr>
<th>Grades</th>
<th>Weight for Age</th>
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<tr>
<td>Normal</td>
<td>&gt;90%</td>
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<tr>
<td>Grade I</td>
<td>75 – 90%</td>
</tr>
<tr>
<td>Grade II</td>
<td>60 – 75%</td>
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<tr>
<td>Grade III</td>
<td>&lt; 60%</td>
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<table>
<thead>
<tr>
<th>Grades</th>
<th>Weight for Age</th>
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<tbody>
<tr>
<td>Normal</td>
<td>&gt;80%</td>
</tr>
<tr>
<td>Grade I</td>
<td>70 – 80%</td>
</tr>
<tr>
<td>Grade II</td>
<td>60 – 70%</td>
</tr>
<tr>
<td>Grade III</td>
<td>50 – 60%</td>
</tr>
<tr>
<td>Grade IV</td>
<td>&lt; 60%</td>
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Table 2: IAP (Indian Academy of Paediatrics) and ICMR

<table>
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<th>Grades</th>
<th>Weight for Age</th>
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<tr>
<td>Normal</td>
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<tr>
<td>Grade I</td>
<td>70 – 80%</td>
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<td>Grade II</td>
<td>60 – 70%</td>
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<tr>
<td>Grade III</td>
<td>50 – 60%</td>
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<tr>
<td>Grade IV</td>
<td>&lt; 60%</td>
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Table 3: Waterlow Malnutrition Classification

<table>
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<tr>
<th>Types/ degree of malnutrition</th>
<th>Cut of level as % of NCHS* median indicator</th>
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<tbody>
<tr>
<td></td>
<td>% weight for age</td>
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<tr>
<td>Normal</td>
<td>&gt; 90</td>
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<tr>
<td>Short duration malnutrition</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>Long duration malnutrition</td>
<td>&lt; 90</td>
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<tr>
<td>( nutritional dwarf)</td>
<td></td>
</tr>
<tr>
<td>Current and long duration</td>
<td>&lt; 90</td>
</tr>
<tr>
<td>malnutrition</td>
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Table 4: Welcome Clinical Classification

<table>
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<tr>
<th>Types</th>
<th>% of weight for age</th>
<th>Oedema</th>
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</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&gt; 80</td>
<td>-</td>
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<tr>
<td>Undernutrition</td>
<td>60 – 80</td>
<td>-</td>
</tr>
<tr>
<td>Kwashiorkor</td>
<td>60 – 80</td>
<td>+</td>
</tr>
<tr>
<td>Marasmus</td>
<td>&lt; 60</td>
<td>-</td>
</tr>
<tr>
<td>Marasmic Kwashiorkor</td>
<td>&lt; 60</td>
<td>+</td>
</tr>
</tbody>
</table>

Most often it is very difficult to know the accurate age among illiterate and rural population therefore, weight for height is the most reliable indicator of nutritional status under this situation.

**Height for Age:** Height for age is the indicator of stunting. If the age of child is known accurately then McLaren’s classification for age may be used.

Table 5: McLaren’s classification Height for Age

<table>
<thead>
<tr>
<th>Grades</th>
<th>% age of height for age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwarf</td>
<td>&lt; 80%</td>
</tr>
<tr>
<td>Short</td>
<td>80 – 93%</td>
</tr>
<tr>
<td>Normal</td>
<td>93 – 105%</td>
</tr>
</tbody>
</table>

**Weight for Height (Age independent):** Weight for height is the indicator of wasting.

\[
\frac{\text{Wt. of the Child}}{\text{Wt. of corresponding for the height of the child}} \times 100
\]

<table>
<thead>
<tr>
<th>Status</th>
<th>% age of weight for height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein energy malnutrition</td>
<td>&lt; 90</td>
</tr>
<tr>
<td>Normal</td>
<td>90 – 120</td>
</tr>
<tr>
<td>Obesity</td>
<td>&gt; 120</td>
</tr>
</tbody>
</table>

**Mid-upper Arm Circumference for age:** Mid arm circumference varies little between the age of one and four years. It correlates well with weight and weight for height. Use of tricolor tape
(Shakir Tape), QUAC stick (arm circumference and height) and arm circumference/ head circumference ratio have been suggested for assessment of nutritional status.

Table 6: Anthropometric measurements of Normal and PEM children

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Normal</th>
<th>PEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rao index (wt. in Kg/ Ht. in cm$^2$)</td>
<td>&gt; 1.5</td>
<td>&lt; 0.15</td>
</tr>
<tr>
<td>Wt./age</td>
<td>Normal</td>
<td>80-60% Kwashiorkor oedema</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 60% Marasmus without oedema</td>
</tr>
<tr>
<td>Skin fold thickness</td>
<td>&gt; 10 mm</td>
<td>&lt; 6 mm</td>
</tr>
<tr>
<td>Bangle test – 4.0 cm diameter</td>
<td>Does not pass</td>
<td>Passes above the elbow</td>
</tr>
<tr>
<td>Mid arm circumference</td>
<td>16 cm</td>
<td>Mild – 13.5 cm, Moderate – 12.5 cm, Severe &lt; 12.5 cm</td>
</tr>
<tr>
<td>Shakir tape</td>
<td></td>
<td>Normal green &lt; 13.5- 16 cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boderline yellow &lt; 12.5- 13.5 cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wasted Red &lt; 12.5 cm</td>
</tr>
<tr>
<td>Kanawati index</td>
<td>&gt; 0.32</td>
<td>Mild – 0.28- 0.32</td>
</tr>
<tr>
<td>Mild arm circumference/Head circumference</td>
<td></td>
<td>Moderate - 0.25-0.28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Severe &lt; 0.02</td>
</tr>
<tr>
<td>Chest circumference/Head circumference</td>
<td>&gt; 1.0</td>
<td>&lt; 1.0</td>
</tr>
</tbody>
</table>

Composite classification

Table 7: Classification of Kanawati and Mcharen’s index of thriving.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Measurements</th>
<th>% Range</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1. Weight</td>
<td>&gt; 100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2. Mid arm circumference</td>
<td>90-100</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80-90</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70-80</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60-70</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;60</td>
<td>5</td>
</tr>
<tr>
<td>II</td>
<td>1. Height</td>
<td>&gt; 100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2. Head circumference</td>
<td>90-100</td>
<td>1</td>
</tr>
</tbody>
</table>
Final score is calculated by adding individual scores for weight, mid arm circumference, height and head circumference.

Normal to children – index = 0-1
Failure to Thrive – index = > 9

**Prediction of Birth Weight of the Newborns**
Maternal height and weight for height (%) are useful in predicting the birth weight of the newborn. Women with height of more than 145 cm and weight of 45 Kg or more are found to have good birth weight and good weight gain during pregnancy. Prematurity rates are very low with better stature, better body weight and better weight/height^2.

**ASSESSMENT OF ADULTS**

**Body Mass Index:** After the cessation of linear growth around 21 years, weight for height indicates muscle fat mass in the adult body.

\[
\text{BMI} = \frac{\text{Weight in Kg}}{\text{Height in meter}^2}
\]

BMI has good correlation with fitness. It may also be used as an indicator of health risk.

<table>
<thead>
<tr>
<th>Presumptive diagnosis</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic energy deficiency- grade III severe</td>
<td>&lt; 16.0</td>
</tr>
<tr>
<td>Chronic energy deficiency- grade II moderate</td>
<td>16.0 – 17.0</td>
</tr>
<tr>
<td>Chronic energy deficiency- grade I mild</td>
<td>17.0 – 18.5</td>
</tr>
<tr>
<td>Low weight – normal</td>
<td>18.5 – 20.0</td>
</tr>
<tr>
<td>Normal</td>
<td>20.0 – 23.0</td>
</tr>
<tr>
<td>Overweight</td>
<td>&gt; 23</td>
</tr>
<tr>
<td>Obesity</td>
<td>&gt; 25</td>
</tr>
</tbody>
</table>

The cut off values for BMI in Table can’t be used for children
For similar BMI, Indians have a greater proportion of body fat which renders them susceptible to morbidity.

**Broka’s Index**
Broka’s Index = Height in cm – 100 = Ideal weight in Kg
Broka’s Index is simple and easy to use index for assessment of nutritional status of adults. Broka’s index correlates with BMI and wt./ht.

**Waist and Hip Circumference Ratio and Mid arm Muscle Circumference:** Waist hip ratio gives distribution of fat in the human body. A waist hip ratio greater than 1.0 in men, 0.8 in women in indicative of android obesity and increases the risk of atherosclerosis.
Innovative Approach in Agriculture Farming

Mid arm muscle circumference (MAMC): It is often used to estimate skeletal muscle mass.  
MAMC (cm) = Upper arm circumference (cm) – (0.134 × TSF) (mm)  
Contrary to BMI, triceps skin-fold distinguishes fat from lean body mass. TSF and MAMC are useful supplements to BMI measures.

(b)  **CLINICAL EXAMINATION:** Clinical examinations assess the levels of health of individuals or of population groups in relation to the food they consume. It is the simplest and practical method. When two or more clinical signs of a deficiency disease are present simultaneously, their diagnostic significance is greatly enhanced.  
Table shows clinical signs and symptoms of nutritional inadequacy in adults for different nutrients.

**Table 9: Clinical signs and symptoms of nutritional inadequacy**

<table>
<thead>
<tr>
<th>Sites</th>
<th>Sign</th>
<th>Deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>General appearance</td>
<td>Loss of subcutaneous fat, Sunken or hollow cheeks</td>
<td>Protein- energy, fluid</td>
</tr>
<tr>
<td>Hair</td>
<td>Easily plucked hair, alopecia</td>
<td>Protein</td>
</tr>
<tr>
<td></td>
<td>dry, brittle hair, corkscrew hair</td>
<td>Protein, Biotin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vitamin C</td>
</tr>
<tr>
<td>Nails</td>
<td>Spooning</td>
<td>Iron</td>
</tr>
<tr>
<td></td>
<td>Transverse lines</td>
<td>Protein</td>
</tr>
<tr>
<td>Skin</td>
<td>Dry and Scaly flaky paint</td>
<td>Vitamin A, Zinc</td>
</tr>
<tr>
<td></td>
<td>Nasolabial seborrhea</td>
<td>Essential fatty acid, riboflavin, Pyridoxine</td>
</tr>
<tr>
<td></td>
<td>Psoriasis form rash</td>
<td>Vitamin A, Zinc</td>
</tr>
<tr>
<td></td>
<td>Pallor</td>
<td>Pyridoxine</td>
</tr>
<tr>
<td></td>
<td>Follicular hyperkeratosis</td>
<td>Vitamin A, zinc</td>
</tr>
<tr>
<td></td>
<td>Perifollicular hemorrhage</td>
<td>Iron, Vitamin B₁₂, Folate</td>
</tr>
<tr>
<td></td>
<td>Easy Bruising</td>
<td>Vitamin A, essential fatty acid</td>
</tr>
<tr>
<td></td>
<td>Hyperpigmentation</td>
<td>Vitamin C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vitamin K, or C, Niacin</td>
</tr>
<tr>
<td>Eyes</td>
<td>Night blindness</td>
<td>Vitamin A, Zinc</td>
</tr>
<tr>
<td></td>
<td>Photophobia, Xerosis, Conjunctival</td>
<td>Riboflavin, Vitamin A</td>
</tr>
<tr>
<td></td>
<td>inflammation</td>
<td>Vitamin E</td>
</tr>
<tr>
<td></td>
<td>Retinal field defect</td>
<td></td>
</tr>
<tr>
<td>Mouth</td>
<td>Glossitis</td>
<td>Riboflavin, Pyridoxine, Niacin, Folic acid, Vitamin B₁₂, Iron</td>
</tr>
<tr>
<td></td>
<td>Bleeding rums</td>
<td>Vitamin C, Riboflavin</td>
</tr>
<tr>
<td></td>
<td>Angular stomatitis</td>
<td>Riboflavin, Pyridoxine, Niacin</td>
</tr>
<tr>
<td></td>
<td>Cheilosis</td>
<td>Riboflavin, Pyridoxine, Niacin, Zinc</td>
</tr>
<tr>
<td></td>
<td>Decreased taste or smell</td>
<td>Niacin</td>
</tr>
<tr>
<td></td>
<td>Tongue fissuring</td>
<td>Riboflavin, Niacin, Iron</td>
</tr>
<tr>
<td></td>
<td>Tongue atrophy</td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td>Signs</td>
<td>Vitamins/Supplements</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------------------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Neck</td>
<td>Goiter</td>
<td>Iodine</td>
</tr>
<tr>
<td></td>
<td>Parotid enlargement</td>
<td>Protein</td>
</tr>
<tr>
<td>Heart</td>
<td>High output failure</td>
<td>Thiamine</td>
</tr>
<tr>
<td>Chest</td>
<td>Respiratory muscle weakness</td>
<td>Protein, Phosphorus</td>
</tr>
<tr>
<td>Abdomen</td>
<td>Ascites</td>
<td>Protein</td>
</tr>
<tr>
<td></td>
<td>Hepatomegaly</td>
<td>Protein, Energy</td>
</tr>
<tr>
<td>Extremities</td>
<td>Edema</td>
<td>Protein, Thiamine</td>
</tr>
<tr>
<td></td>
<td>Atoxia</td>
<td>Vitamin B&lt;sub&gt;12&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td>Bone tenderness</td>
<td>Vitamin D, Calcium, Phosphorus</td>
</tr>
<tr>
<td></td>
<td>Bone/Joint pain</td>
<td>Vitamin A or C</td>
</tr>
<tr>
<td></td>
<td>Muscle pain</td>
<td>Thiamine</td>
</tr>
<tr>
<td></td>
<td>Hyporeflexia</td>
<td>Thiamine</td>
</tr>
<tr>
<td></td>
<td>Muscle wasting and weakness</td>
<td>Protein, Calorie, Vitamin D, Selenium, Sodium chloride</td>
</tr>
<tr>
<td></td>
<td>Joint Swelling</td>
<td>Vitamin C</td>
</tr>
<tr>
<td>Thorax</td>
<td>Thoracic roasary</td>
<td>Vitamin D</td>
</tr>
<tr>
<td>Muscles</td>
<td>Atrophic muscle</td>
<td>Protein</td>
</tr>
<tr>
<td></td>
<td>Decreased grip strength</td>
<td>Protein</td>
</tr>
<tr>
<td>Neurological</td>
<td>Dementia</td>
<td>Thiamine, Vitamin B&lt;sub&gt;12&lt;/sub&gt;, Folate, Niacin</td>
</tr>
<tr>
<td></td>
<td>Acute disorientation</td>
<td>Phosphorus, Niacin</td>
</tr>
<tr>
<td></td>
<td>Nystagmus</td>
<td>Thiamine</td>
</tr>
<tr>
<td></td>
<td>Ophthalmoplegia</td>
<td>Thiamine</td>
</tr>
<tr>
<td></td>
<td>Wide-based gait</td>
<td>Thiamine, Pyridoxine, Vitamin E</td>
</tr>
<tr>
<td></td>
<td>Peripheral neuropathy</td>
<td>Vitamin B&lt;sub&gt;12&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td>Loss of vibratory sense</td>
<td>Vitamin B&lt;sub&gt;12&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td>Loss of position sense</td>
<td>Calcium, Magnesium</td>
</tr>
<tr>
<td></td>
<td>Tetany</td>
<td>Thiamine, Vitamin B12</td>
</tr>
<tr>
<td></td>
<td>Paresthesias</td>
<td>Thiamine</td>
</tr>
<tr>
<td></td>
<td>Wrist or foot drop</td>
<td>Iodine</td>
</tr>
<tr>
<td></td>
<td>Diminished reflexes</td>
<td></td>
</tr>
</tbody>
</table>

Source: Shils Maurice E. et al. (Editors), 1998, Modern nutrition in health and disease, Lippincott Williams & Wilkins, Philadelphia.
For clinical examination cooperation of the subject can be achieved easily because the procedure is noninvasive and symptoms are observed externally. This method is reliable and easy to organize. Age of the subject need not be ascertained. Symptoms are specific to a particular nutrient deficiency. This method is not very expensive. It does not require elaborate apparatus and reagents. However, it requires an experienced investigator to assess the symptoms. Early clinical symptoms and signs of malnutrition are rather vague and often include weakness, lethargy, irritability and light headedness. Many of the symptoms and signs are nonspecific for a single nutrient deficit and may be caused by insufficiency of one or several nutrients e.g., flaking dermatitis may be due to protein, riboflavin or linoleic acid and deficiency. Some symptoms like angular stomatitis may be due to several deficiencies. Change in the conjunctiva, lips and skin caused by non nutritional factors like cold, dryness, irritation and infection. In a well nourished community, signs of malnutrition are infrequent and so more easily overlooked or misinterpreted.

**ICMR score card for clinical assessment of nutritional status**

With a view to minimizing errors in clinical assessment the nutrition advisory committee of the Indian Council of Medical Research evolved a score card for assessing the various clinical signs and symptoms. This score card has been widely used in India in all nutrition surveys and has proved useful in assessing the improvement in nutritional status brought by food supplements. A shorter score card for assessing only the more common deficiencies can be used for rapid nutrition survey of school children.

**Method of reporting results:** The results of surveys carried out in India among pre-school children are given in Table 10. The incidence of the various signs and symptoms are best expressed as ‘percentage’ of the total number examined.

**Table 10: Nutritional Assessment Schedule**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Appearance</td>
<td>Good</td>
<td>Fair</td>
<td>Poor</td>
<td>Very poor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II. Eyes</td>
<td>Absent, glistening and moist</td>
<td>Slightly dry on exposure for a minute, lack of luster</td>
<td>Conjunctiva dry and wrinkled</td>
<td>Conjunctiva very dry and Bitot’s Spots present</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A) Conjunctiva</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Xerosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Pigmentation</td>
<td>Normal</td>
<td>Sight discolouration</td>
<td>Moderate</td>
<td>Severe earthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(38)
## Innovative Approach in Agriculture Farming

<table>
<thead>
<tr>
<th></th>
<th>colour</th>
<th>browning in patches</th>
<th>discolouration</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Discharge</td>
<td>Absent</td>
<td>Watery, excessive lachrymation</td>
<td>Mucopurulent</td>
</tr>
<tr>
<td>(B) cornea 10. Xerosis</td>
<td>Absent</td>
<td>Slight dryness and diminished sensibility</td>
<td>Haziness and diminished transparency</td>
</tr>
<tr>
<td>11. Vascularization</td>
<td>Absent</td>
<td>Circumcorneal injection</td>
<td>Vascularization of cornea</td>
</tr>
<tr>
<td>(C) Lids 12. Excoriation</td>
<td>Absent</td>
<td>Slight excoriation</td>
<td>Blepharitis</td>
</tr>
<tr>
<td>13. Folliculosis</td>
<td>Absent</td>
<td>A few granules</td>
<td>Lids covered with extensive granules</td>
</tr>
<tr>
<td>14. Angular conjunctivitis</td>
<td>Absent</td>
<td>Present</td>
<td>-</td>
</tr>
<tr>
<td>D) Functional 15. Night blindness</td>
<td>Absent</td>
<td>Present</td>
<td>-</td>
</tr>
<tr>
<td>III. Mouth  (A) Lips 16. Condition</td>
<td>Normal</td>
<td>Angular stomatitis, mild</td>
<td>Angular stomatitis, marked</td>
</tr>
<tr>
<td>(B) Tongue 17. Colour</td>
<td>Normal</td>
<td>Pale but coated</td>
<td>Red and raw</td>
</tr>
<tr>
<td>18. Surface</td>
<td>Normal</td>
<td>Fissured</td>
<td>Ulcered</td>
</tr>
<tr>
<td>(C) Buccal mucosa 19. Condition</td>
<td>Normal</td>
<td>Stomatitis</td>
<td>-</td>
</tr>
<tr>
<td>(D) Gums 20. Condition</td>
<td>Normal</td>
<td>Bleeding and / or gingivitis</td>
<td>Pyorrhoea</td>
</tr>
<tr>
<td>(E) Teeth 21. Fluorosis</td>
<td>Absent</td>
<td>Chalky teeth</td>
<td>Pitting of teeth</td>
</tr>
<tr>
<td>22. Caries</td>
<td>Absent</td>
<td>Slight</td>
<td>Marked</td>
</tr>
<tr>
<td>(IV) Hair 23. Condition</td>
<td>Normal</td>
<td>Loss of luster</td>
<td>Discolored and dry</td>
</tr>
<tr>
<td>(V) Skin (A) General 24. Appearance</td>
<td>Normal</td>
<td>Loss of luster</td>
<td>Dry and rough or crazy pavements</td>
</tr>
<tr>
<td>25. Elasticity</td>
<td>Normal</td>
<td>Diminished</td>
<td>Wrinkled skin</td>
</tr>
<tr>
<td>(B) Regional</td>
<td>Normal</td>
<td>Collar like</td>
<td>-</td>
</tr>
</tbody>
</table>

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### Innovative Approach in Agriculture Farming

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>26. Trunk</strong></td>
<td></td>
<td>pigmentation and dermatitis around the neck</td>
<td></td>
</tr>
<tr>
<td><strong>27. Face</strong></td>
<td>Normal</td>
<td>Nosolabial seborrhoea</td>
<td>Symmetrical sub-orbit pigmentation</td>
</tr>
<tr>
<td><strong>28. Perineum</strong></td>
<td>Normal</td>
<td>Scrotal or pudendal dermatitis</td>
<td>-</td>
</tr>
<tr>
<td><strong>29. Extremities</strong></td>
<td>Normal</td>
<td>Symmetrical dermatitis with pigmentation of glove or stocking type</td>
<td></td>
</tr>
</tbody>
</table>

#### VI. Adipose Tissue
(to be judged by the examination of the arm over the biceps)

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>30. Quantity</strong></td>
<td>Normal</td>
<td>Deficient</td>
<td>-</td>
</tr>
</tbody>
</table>

#### VII. Oedema
31. Distribution

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Absent</strong></td>
<td>Oedema on dependent parts</td>
<td>Oedema on face and dependent parts</td>
<td>General anasarca</td>
</tr>
</tbody>
</table>

#### VIII. Bones
32. Condition

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Stigmata of past rickets</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

#### IX. Heart
33. Size

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Apex just outside the nipple line</td>
<td>Enlarged</td>
<td>-</td>
</tr>
</tbody>
</table>

#### X. Alimentary system
34. Appetite

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Anorexia</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

35. Stool

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal evacuation</td>
<td>Diarrhea</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

36. Liver

<table>
<thead>
<tr>
<th></th>
<th>Palpable</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not palpable</td>
<td>Palpable</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

37. Spleen

<table>
<thead>
<tr>
<th></th>
<th>Palpable</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not palpable</td>
<td>Palpable</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

#### XI. Nervous System
38. Calf tenderness

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>Present</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

39. Paresthesia

<table>
<thead>
<tr>
<th></th>
<th>Present</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>Present</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

N.B. – Exclude other eye diseases not associated with nutritional deficiency

Innovative Approach in Agriculture Farming

(c) BIOPHYSICAL OR RADIOLOGICAL MEASUREMENT: These tests are used in specific studies where additional information regarding change in the bone or muscular performance is required. Radiological methods have been used in studying the change of bones in rickets, osteomalacia, osteoporosis and scurvy.

When clinical examination suggests following radiographic examination is done:

i) In rickets, there is healed concave line of increased density at distal ends of long bones usually the radius and ulna.

ii) In infantile scurvy there is ground glass appearance of long bones with loss of density.

iii) In beriberi there is increased cardiac size as visible through X – rays.

iv) Changes in bone also occur in advanced flurosis.

v) Endocardiograph, a tool for graphing heart sounds and a means for measuring nutritional status.

These give more accurate information. The results can be used as a supporting data for other methods. Equipment required is expensive and technical knowledge is required in interpreting data. It is difficult to transport the equipment to interior parts of the country viz. villages.

Bioelectric Impedance Tests (BIA): It is body composition measurements technique based on the principle that lean tissue has higher electrical conduction and lower impedance than fat. It uses resistance and reactance to estimate fat free and fat mass. Electrodes on the extremities are stimulated. The greater electrolyte content and conductivity of the body fat free mass is compared with that of fat or bone. Tissues rich in water and electrolytes allow an electric current to pass with greater ease than do denser fat and bone.

(d) FUNCTIONAL ASSESSMENT

Functional indicators of nutritional status are diagnostic tests to determine the sufficiency of host nutriment to permits cells, tissues, organs, anatomical systems or the host him/herself to perform optimally the intended nutrient dependent biological function.

Functional indices of nutritional status include cognitive ability, disease response, reproductive competence, physical activity, work performance and social and behavioural performance.

Submaximal test: Using tread mill might be useful as an adjunct to biochemical and anthropometric measures in the assessment of nutritional status. Increased severity of malnutrition is associated with an increased heart rate response to the same submaximal work rate. The heart rates and O₂ intakes are obtained during maximal O₂ consumption test by using treadmill.

Growth Velocity: It represents a more rates sensitive and at the same time a functional index. Growths rates are suboptimal in PEM, zinc deficiency and iodine deficiency. The use of this index requires serial, accurate anthropometric measurements. Severe deficiencies of several nutrients will delay the one set of menarche. Chronic malnutrition will influence sexual maturation.
**Fertility and birth weight:** It reflects nutritional status at the population level. Nutritional supplements can reduce the duration of postpartum amenorrhoea.

**Social performance:** The ability of an individual to interact with peers and environment is an index for functional status. Prenatally undernourished infants show several behavioural impairments that could negatively affect development of social competence including reduced activity and less interaction with caretakers.

**Table 11: System classification of functional indices of nutritional status**

<table>
<thead>
<tr>
<th>System</th>
<th>Nutrients involved</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Structural Integrity</strong></td>
<td></td>
</tr>
<tr>
<td>Erythrocytes fragility</td>
<td>Vitamin E, Selenium</td>
</tr>
<tr>
<td>Capillary fragility</td>
<td>Vitamin C,</td>
</tr>
<tr>
<td>Tensile strength of skin</td>
<td>Copper</td>
</tr>
<tr>
<td>Experimental wound healing</td>
<td>Zinc</td>
</tr>
<tr>
<td>Lipoprotein peroxidation</td>
<td>Vitamin E</td>
</tr>
<tr>
<td><strong>II. Host defence</strong></td>
<td></td>
</tr>
<tr>
<td>Leucocyte phagocytic activity</td>
<td>Protein, Energy, Iron</td>
</tr>
<tr>
<td>Leucocyte metabolism</td>
<td>Protein, Energy</td>
</tr>
<tr>
<td>White cell interferon production</td>
<td>Protein, Energy</td>
</tr>
<tr>
<td><strong>III. Transport</strong></td>
<td></td>
</tr>
<tr>
<td>1. Intestinal absorption</td>
<td></td>
</tr>
<tr>
<td>Iron absorption</td>
<td>Iron</td>
</tr>
<tr>
<td>Cobalt absorption</td>
<td></td>
</tr>
<tr>
<td>2. Plasma tissue transport</td>
<td>Zn</td>
</tr>
<tr>
<td>Zinc uptake by erythrocyte</td>
<td></td>
</tr>
<tr>
<td>Retional relative dose response</td>
<td>Vitamin A</td>
</tr>
<tr>
<td><strong>IV. Haemoistasis</strong></td>
<td></td>
</tr>
<tr>
<td>Prothrombin time</td>
<td>Vitamin K</td>
</tr>
<tr>
<td>Platelet aggregation</td>
<td>Vitamin E, Zinc</td>
</tr>
<tr>
<td><strong>V. Reproduction</strong></td>
<td></td>
</tr>
<tr>
<td>Sperm count</td>
<td>Energy, Zinc</td>
</tr>
<tr>
<td><strong>VI. Nerve Function</strong></td>
<td></td>
</tr>
<tr>
<td>Dark adaptation</td>
<td>Vitamin A, Zinc</td>
</tr>
<tr>
<td>Olfactory acuity</td>
<td>Vitamin A, B_{12} and Zinc</td>
</tr>
<tr>
<td>Taste acuity</td>
<td>Vitamin A, Zinc</td>
</tr>
<tr>
<td>Nerve conduction</td>
<td>Protein, Energy, Vitamin B_{1} and B_{12}</td>
</tr>
<tr>
<td><strong>VII. Work capacity Haemodynamics</strong></td>
<td></td>
</tr>
<tr>
<td>Task performance endurance</td>
<td>Protein, Energy, Vitamin B_{1}, B_{2}, B_{6} and Iron</td>
</tr>
<tr>
<td>Heart rate (cumulative)</td>
<td>Protein, Energy and Iron</td>
</tr>
</tbody>
</table>

Laboratory measurements are another tool in the diagnosis of malnutrition although certain laboratory abnormalities that could reflect malnutrition can also have a non-nutritional cause (e.g., calcium, albumin, hematocrit). The establishment of normal nutrient values in body fluids or tissues for each sex and age group varies from laboratory to laboratory and the normal range usually represents a mean ± 2 SD of a normal population.

A) Laboratory Tests

i) Haemoglobin estimation: It is a useful index of the overall state of nutrition irrespective of its significance in anaemia. RBC count and a haematocrit are also valuable.

ii) Stool and urine analysis: Stools should be examined for intestinal parasites. History of parasitic infections, chronic dysentery and diarrheaa provides useful background information about the nutritional status of persons. Urine should be examined for albumin and sugar.

B) Biochemical Tests: In the development of any deficiency disease, biochemical changes can be expected to occur prior to clinical manifestation. Therefore, biochemical tests which can be conducted on easily accessible body fluids such as blood and urine can help to diagnose disease at the sub-clinical stage. These tests confirm clinical diagnoses are nonspecific.

Biochemical tests are precise and measure individual nutrient concentration in body fluids (serum retinol, serum iron) or detection of abnormal amounts of metabolites in urine (urinary iodine) frequently after a loading dose or measurements of enzymes in which the vitamin is a known co-factor (riboflavin deficiency) to help establish malnutrition in its preclinical stages. Modern analytical instruments (high performance liquid chromatography) techniques (radio or enzyme immunoassay) and computerization have greatly increased the capability of nutritional biochemical testing. Table 8 shows normal and deficiency indices for assessing status with regards to vitamins and minerals.

**Table 12: Biochemical methods for assessing nutritional status**

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Principle method</th>
<th>Normal</th>
<th>Deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>S. vitamin A Relative dose response (RDR) test (450-1000 µg retinol) 100µg/Kg dehydroretinol; Dehydroretinol: Vitamin A</td>
<td>30 µg/dl -</td>
<td>&lt; 20 µg/dl &gt; 20 % RDR</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>S. 25- hydroxy cholecalciferol</td>
<td>&gt; 10 ng/ml</td>
<td>&gt; 5 ng/ml</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>S. vitamin E/ total lipid ratio</td>
<td>&gt; 0.8</td>
<td>-</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>Protein induced by vitamin K absence PIVKAS</td>
<td>Absent</td>
<td>Accumulate</td>
</tr>
<tr>
<td>Thiamine</td>
<td>Urinary thiamine Erythrocyte Transketolase Test (ETK-AC) Activated coefficient)</td>
<td>100 µg/24 hr. 65µg/g of creatinine &lt; 1.15</td>
<td>- &gt; 1.25</td>
</tr>
</tbody>
</table>

(43)
### Tests for Protein Energy Malnutrition

**i) Serum Protein:** The first indicator of malnutrition is the lowering of serum total proteins and serum albumin. The normal albumin levels are 3.5- 5.5 g/dl. During PEM the levels may slow down to 2.0 to 2.5 g/dl. α-globulin and γ-globulin fractions show a small rise but the albumin globulin ratio shows a tendency to decrease. Serum transferring < 0.45 mg/ml suggests severe malnutrition.

**ii) Serum Amino Acid Ratio:** This ratio of non-essential amino acids is very sensitive at an early stage of PEM also for kwashiorkor. This test is not sensitive to marasmus.

Serum Amino Acid Ratio = Glycine + Serine + Glutamine + Taurine / Leucine + Isoleucine + Valine + Methionine

---

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Description</th>
<th>Reference Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riboflavin</td>
<td>Erythrocyte glutathione reductase (EGR0AC)</td>
<td>&lt; 1.2</td>
</tr>
<tr>
<td>Niacin</td>
<td>N- methyl 1-2 pyridone-5 carboxylamide (2–pyridine) and N1- methyl nicotinamide ratio</td>
<td>1 – 4</td>
</tr>
<tr>
<td>Vitamin B₆</td>
<td>Urinary excretion B₆ Erythrocyte aspirate amino transferase (EAspAT₆)</td>
<td>&lt; 1.7- 2.0</td>
</tr>
<tr>
<td>Folic acid</td>
<td>Serum folate, RBC folate, Formimino glutamic acid FIGLU</td>
<td>&gt; 6.0 ng/ml</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 160 ng/ml</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 20 mg FIGLU in 8 hr. after histidine load of 0.26 g/Kg body weight</td>
</tr>
<tr>
<td>Vitamin B₁₂</td>
<td>Serum B₁₂</td>
<td>200-900 pg/ml</td>
</tr>
<tr>
<td>Ascorbic acid</td>
<td>P. ascorbic acid levels, Leucocyte ascorbic acid</td>
<td>&gt; 0.3 mg/dl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 15 mg/dl</td>
</tr>
<tr>
<td>Iron</td>
<td>Serum ferritin levels, Serum iron, Serum transferring, Haemoglobin</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 13 g/dl (Men), &gt;12 g/dl (Women)</td>
</tr>
<tr>
<td>Iodine</td>
<td>Urinary excretion of iodine</td>
<td>&gt; 50 mg/g creatinine</td>
</tr>
<tr>
<td>Zinc</td>
<td>P. zinc</td>
<td>84- 104 µg/dl</td>
</tr>
<tr>
<td>Copper</td>
<td>S. copper</td>
<td>75- 125 µg/dl</td>
</tr>
</tbody>
</table>
Normal mean value = -1.5, Sub-clinical malnutrition = -2 to 4, Frank kwashiorkor mean value = -5

**Fasting Urinary Nitrogen and Creatinine Ratio**

Urea-creatinine ratio = \( \frac{\text{mg urea nitrogen/ml}}{\text{mg creatinine nitrogen/ml}} \)

Children eating diets low in protein show low ratio of urinary urea to creatinine.

**Assessment of Protein Catabolic Rate Using Urinary Urea Nitrogen**

Because urea is a major by-product of protein catabolism, the amount of urea nitrogen excreted each day can be used to estimate the rate of protein catabolism and determine if protein intake is adequate to offset it. Total protein loss and protein balance can be calculated from the urinary urea nitrogen (UUN) as follows:

Protein catabolic rate (g/day) = \((24 \text{ hr. UUN (g)} + 4) \times 6.25\)

The value of 4 g added to the UUN represents unmeasured nitrogen lost in the urine, sweat, hair, skin and faeces. The factor 6.5 is used as nitrogen accounts for about one sixth the weight of dietary protein.

Protein balance (g/day) = Protein intake – Protein catabolic rate

**II Indirect Method**

(a) **Dietary Assessment or survey**

A diet survey provides information about dietary intake patterns of specific food consumed and estimated nutrient intakes. It indicates relative dietary inadequacies, which is helpful in planning health education activities and changes needed in the agriculture and food production industries. Most of the time, the surveys are carried out for 7-10 days. If needed, in different seasons can be repeated.

i) **Inventory method:** This method is generally employed among homogenous of people, consuming food from a common kitchen, e.g. hostels, orphanages, army barracks and homes for aged. This method aims at recording acquisitions and changes in food inventory of the organization during the survey period, which is generally one week period. The amount of food stuffs issued in the kitchen as per the records maintained by the warden is taken into consideration for computing of food intake. No direct measurement or weighing is done. This method can also be adopted for assessing food consumption at household level, provided the respondent maintains food record systematically.

The average intake per person per day is calculated as follows:

\[
\text{Stocks at the beginning of week} - \text{Stocks at the end of the week} \div \text{Total no. of inmates taking the meal} \times \text{No. of days of survey}
\]

ii) **Food frequency questionnaire:** This method is designed to obtain qualitative information about usual food consumption patterns. The questionnaire consists of two aspects. (i) a list of foods and (ii) a set of frequency of use response categories. The lists of foods are mostly focused on specific food groups, particular foods, or food consumed and the frequency of consumption.
The aim of the food frequency questionnaire is to assess the frequency with which certain food items or food groups are consumed during a specific time period, e.g., daily, weekly, or monthly.

**iii) Weighment method:** In this method, the food consumed is weighed accurately using a balance with the help of a structure diet survey schedule. This method is used for weighing raw and cooked foods. In community surveys, usually raw food is weighed, since it is easy and meets with lesser resistance from respondents. The investigator visits the household selected for the study and weighs all raw foods to be utilized for that day before cooking and the number of people consuming food in the family is recorded. It is ideal to conduct the survey for seven consecutive days to obtain the true picture of the diet. However, depending on the purpose of study, the period of survey can be modified.

**iv) Expenditure pattern method:** With the help of a specially designed questionnaire, money spent on food and non-food items is assessed. It is considered as a good proxy for weighment method of diet survey. In this method, weighment of food is not done, but needs more time as additional data on price of individual food items and qualitative aspects of diet through frequency method becomes necessary for obtaining a realistic picture of the community.

**v) Diet History:** This method is useful for obtaining qualitative details of diet and studying patterns of food consumption at household level. The procedure includes assessment of the frequency of consumption of different foods daily or number of times in a week, fortnight, or occasionally. This method is useful to study (i) meal patterns, (ii) dietary habits and (iii) people’s food preferences and avoidances during various physiological conditions, such as pregnancy, lactation, sickness, infant feeding practices and the associated cultural constraints which affect food intake. It is also possible to get information on approximate quantities of foods consumed by the family in terms of gross weight, for example, 30 Kg of rice per month or 5 Kg of oil per month.

**vi) Twenty-four hour recall method (oral questionnaire):** In this method, the respondents are asked by the interviewer, who has been trained in interviewing techniques to recall the exact foods intake of the individual/family during the previous twenty-four hour period or preceding day. Detailed description of all foods and drinks consumed, including cooking practices are recorded. Vitamin and mineral supplements used is also noted. Quantities of food consumed are usually determined with the help of a set of standardized containers of different capacities, suitable to local conditions. The sequential steps involved are:

1. The respondent is asked about the type of food preparation made at breakfast, lunch, tea time, and dinner.
2. An account of the raw ingredients used for each of the preparation is obtained.
3. Information of the total cooked amount of each preparation using standardized containers.
4. The intake of each food preparation by every individual in the family is assessed in terms of standardized containers. These cups are used mainly to aid the respondent to recall the quantities prepared and consumed by individual member.
vii) **Chemical analysis of duplicate samples:** In this method, the individual under study is required to save (separately) a duplicate sample of every food eaten by him during the day. These samples are then analyzed in the laboratory for nutrient analysis. This is a very accurate method but is costly and needs laboratory support. This method will be useful for scientific study on a small group of people.

viii) **Dietary score:** This method will be useful to assess the intake of specific nutrient under study. The sources of the nutrients are assigned score on the basis of the content of the nutrient. The consumption of the particular food by an individual is estimated through frequency method. For example, sources of vitamin A/ Caroiene-score for milk-1, egg-2, green leafy vegetable-3 and so on. The frequency of consumption of foods, the total score percentages are then calculated. The value of this method is enhanced when it is combined with quantitative method of survey and nutritional status assessment.

ix) **Weighed food records:** In a weighed record, the subject, parent or caretaker is instructed to weigh all foods consumed by the subject during a specific period of time. Such data will be useful for diet counseling and when data has to be correlated with biological parameters.

(b) **Vital Health Statistics:** The term vital statistics signifies the data and analytical methods for describing the vital events occurring in communities. The raw data of vital statistics are generally obtained through the sources of population census, sample surveys and vital statistics registers.

For public health and nutrition, the vital statistics are most useful. Vital statistics include the counts of births, deaths, illness, movements and the various statistical techniques like rates and ratios obtained from them and utilized.

**Parameters used under vital statistics**

i) Neonatal mortality rate  
ii) Pre- school mortality rate  
iii) Disease specific mortality rate  
iv) Maternal mortality rate  
v) Family size  
vi) Fertility rate  
vii) Eligible couple  
viii) Incidence or prevalence of chronic disease like T.B., Malaria

**Socio- Economic Status**

Nutritional status of community =

\[
\frac{\text{Extent of production of food grains} - \text{consumption} + \text{storage} + \text{income} + \text{education etc}}{\text{Number of person}}
\]

Some types of malnutrition have a particularly high incidence at certain ages so that the mortality rates at these specific age periods have been suggested as indicators of the incidence of certain type of malnutrition. Malnutrition can be either the direct cause or indirect cause. There are measures of fertility, mortality and morbidity under vital health statistics.

**Measure of Mortality**

**Infant mortality rate:** This is the number of babies dying in the year of life per 1000 live births. The IMR is falling as there is improvement in infant feedings. In most prosperous countries the rate lies between 10 and 20.
Infant mortality rate = \frac{\text{Number of deaths under one year of age in a year}}{\text{Number of live births in a year}} \times 100

**Perinatal mortality rate:** This is the number of deaths of infants under 1 month and stillbirths per 1000 total births. This rate gives an index of maternal nutrition through many other factors like genetic makeup of mother and child, the degree of exposure to infections and the standard of medical care available.\text{PNMR} = \frac{\text{Late foetal deaths after 28 weeks or more gestation + Deaths under one week}}{\text{Mid year population of the same age group in the same year}} \times 100

**Toddler mortality rate:** This is the number of deaths between 1 to 4 years per 1000 toddlers born. The manifestations and effects of malnutrition are well known to be severe in toddlers. Although death certificates may record gastroenteritis or respiratory infections, malnutrition contributes to many deaths. In addition, disease specific mortality rate, maternal mortality rate, family size and fertility rate are also an indication of nutritional status of community. If in any community, the prenatal, infant and toddler mortality rates all fall, then it can be inferred that the general level of nutrition of the people is improving.

**Measures of Morbidity:** Morbidity relates to types and varieties of diseases one faces or experiences affecting the day to day activity. The following measures are used to quantify morbidity.

\text{Incidence rate} = \frac{\text{Total number of new cases of a specific disease during year}}{\text{Mid year population}} \times k

\text{Prevalence rate} = \frac{\text{Total number of new or old cases existing at a point of time}}{\text{Total population at that point of time}} \times k

K can be 100, 1000, 10000 or 100000

Case fatality and immunity ratio are also measures of morbidity.

**Table 13: Information useful from assessment of nutritional status**

<table>
<thead>
<tr>
<th>Sources of information</th>
<th>Nature of information obtained</th>
<th>Nutritional implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural data, food balance studies</td>
<td>Gross estimates of agricultural production, agricultural methods, soil fertility, predominance of cash crops over production of staples, food imports and exports.</td>
<td>Approximate availability of food supplies to a population</td>
</tr>
<tr>
<td>Socio economics data. Information on marketing, distribution and storage</td>
<td>Purchasing power, distribution and storage of food stuff</td>
<td>Unequal distribution of available foods between the socio economic groups in the community nutrient intake.</td>
</tr>
<tr>
<td>Food consumption pattern, cultural, anthropological data</td>
<td>Lack of knowledge, erroneous, belief and</td>
<td>Unbalanced nutrients intake</td>
</tr>
</tbody>
</table>
## Innovative Approach in Agriculture Farming

<table>
<thead>
<tr>
<th>Dietary surveys</th>
<th>Food consumption, distribution within the family</th>
<th>Low, excessive or unbalanced nutrient intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special studies on foods</td>
<td>Biological value of diets, presence of interfering factor effect of food processing</td>
<td>Special problems related to nutrient utilization</td>
</tr>
<tr>
<td>Vital and health statistics</td>
<td>Morbidity and Mortality data</td>
<td>Extent of risk to community. Identification of high risk group.</td>
</tr>
<tr>
<td>Anthropometric studies</td>
<td>Physical development</td>
<td>Effect of nutrition on physical development</td>
</tr>
<tr>
<td>Clinical nutrition survey</td>
<td>Physical signs</td>
<td>Deviation from health due to malnutrition</td>
</tr>
<tr>
<td>Biochemical studies</td>
<td>Levels of nutrients, metabolites and other components of body tissues</td>
<td>Nutrient supplies in the body, impairment of biochemical functions in tissues and fluids.</td>
</tr>
<tr>
<td>Additional medical information</td>
<td>Prevalent diseases including infections</td>
<td>Inter relationship between state of nutrition and diseases.</td>
</tr>
</tbody>
</table>

(c) **Subjective Global Assessment (SGA)** : It is modern nutrition assessment tool that relies on history of weight and dietary change, persistent gastrointestinal symptoms, functional capacity, effect of disease on nutritional requirements and physical appearance. The SGA has been well tested and is widely accepted as a practical and reliable tool for nutrition assessment.

**Table 14: Feature of Subjective Global Assessment**
(Select appropriate category with a check mark or enter numerical value where indicated by#)

### A. History

1. **Weight change**
   - Overall loss in past 6 months:
     - Amount = ....##...Kg; % loss = ....##....
     - Change in past 2 weeks ...... Increase
       - ...... No change
       - ...... Decreased

2. **Dietary intake change (Relative to Normal)**
   - ...... No change
   - ...... Change ...... Duration = ...... Weeks
     - Type ...... Suboptimal Solid Diet ...... Full Liquid Diet
     - ...... Hypo Caloric Liquids ...... Starvation

3. **Gastrointestinal Symptoms (that persisted for > 2 weeks)**
   - ...... None ...... Nausea ...... Vomiting .....Diarrhoea ......Anorexia

4. **Functional Capacity**
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…. No Dysfunction (e.g. Full Capacity)
…… Dysfunction …… Duration = …… Weeks
Type ……. Working Sub Optimally
……. Ambulatory
……. Bedridden

5. Disease and its relation nutritional requirements
Primary Diagnosis (Specify) ……. 
Metabolic Demand (Stress) …… No stress …… Low stress
…… Moderate stress ……. High stress

B. Physical
(for each trait specify 0 = Normal, 1+ = Mild, 2+ = Moderate, 3+ = Severe)
# …… loss of subcutaneous fat (triceps, chest)
# …… muscle wasting (quadriceps, deltoids)
# …… ankle edema
# …… sacral edema
# …… ascites

C. SGA Rating
…… A = Well Nourished
…… B = Moderate Malnourished or suspected of being malnourished)
…… C = Severely Malnourished
Source: Detsky et al., What is subjective global assessment? JPEN 11:8, 1987

Importance of Nutritional Assessments

i) Reducing chronic disease risk
ii) Promoting health
iii) Managing health care costs
iv) Identify groups at nutritional risk
v) Monitors quality of food supply
vi) Measures the nutrient intake of individuals
vii) Identifies diet/ disease relationships
viii) Determines population health status
ix) Evaluates effects of nutrition interventions

Questions
1. What are the different anthropometric measurements and how are these taken?
2. What do you understand by anthropometry?
3. List the methods used to assess the nutritional status of a community?
4. Discuss different classification of anthropometric measurements and how these can be used for assessment of nutritional status?
5. Give the clinical signs used to find out the nutritional status of an individual.
6. Explain the following and bring out the differences among them:
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i) Gomez classification  ii) IAP classification  iii) Waterlow classification  iv) Welcome classification
7. What are the different dietary methods used to know the nutritional status of a community?
8. Which biochemical tests are used to assess the protein energy malnutrition?
9. Explain the sequence of nutritional deficiency and specificity of assessment of nutritional status of a community?
10. What is BMI? How do you classify malnutrition using this index?
11. Give the list of biophysical or radiological measures used in different deficiency diseases.
12. Explain indirect methods of assessing nutritional status.
13. How are functional tests compared to other methods? Are they superior or inferior? Why?
14. Which biochemical tests are used to assess the fat soluble vitamins nutrition status?
15. What kind of laboratory tests are used for nutritional assessment?
17. “Diet surveys may not give the accurate value in knowing the nutritional status”. Give reasons.
18. Define the following:   a) Infant Mortality Rate   b) Perinatal Mortality Rate   c) Toddler Mortality Rate
19. How will you assess the vitamin A nutritional status of preschool children?
20. How will you assess the iron nutritional status of an adolescent community?

REFERENCES

PARTICIPATION OF RURAL WOMEN IN LIVESTOCK MANAGEMENT

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ABSTRACT

The present study was carried out to ascertain the Participation of rural women in Livestock management activities. The sample considered of 120 randomly selected rural women in Bhatparrani Tehsil of Deoria District U.P. Interview technique was used for data collection. Frequency distribution, Percentage, MWS and Correlation were used to analyze data statistically. Finding of the study shows that a majority of the respondents that maximum 68.33 percent of respondents belonged to the age group of 31-45 years, (76.66%) belonged to the backward caste, 55.83 percent of respondents were illiterate, Regarding family structure more than half of the (53.33%) were from the joint family, maximum 64.16 percent respondents possessed 1 to 2.5 acre land holding, 86.66 percent had medium herd size. The probable reason may be educated women consider these activities below dignity and prefer their involvement in other sectors. On the other hand, larger the land holding, the participation in livestock rearing was found to be lesser; the problem reason may be because of shifting to other subsidiary accusation.

Key words- Participation, Rural Women, Livestock management.

INTRODUCTION

The contribution of women to national development in the current context and its potential is of greater significance. The prosperity and growth of a nation also depends on the status and development of women as they not only constitute nearly half of the population, but also positively influence the growth of remaining half of the population.

Women play significant and crucial role in agricultural and livestock management. Most of the works related to livestock management are looked after by rural women. There are a number of livestock management activities performed by women viz. chopping of fodder, feeding the animal, milking, preparation of milk product, cleaning of cattle shed, disposed of garbage to compost pit, making cow dung cakes, preparing compost, carrying manure to field etc. Despite women considerable involvement and contribution, their role in livestock management has often been underestimated undervalued and largely ignored. Moreover they are denied of most of the developmental activities. Therefore the present investigation was designed the livestock management activities especially in Deoria district of Uttar Pradesh with following specific objectives (i) To ascertain the socio-economic characteristics of the respondents. (ii) To study the participation of rural women in various activities of livestock management.
METHODOLOGY
The present study was conducted in purposively selected Bhatpar Rani Tehsil of Deoria district covering six villages i.e. Malhana, Jamuniadih, Laxmanchak, Jiraso, Malhani, and Khampar were selected purposively for the study. For sample selection a village wise list of rural families who possessed more than 3 milch animals was prepared from this list, 20 respondents from each village making a total sample of 120 women were selected randomly. Interview technique was used for data collection. Frequency distribution, Percentage, MWS and Correlation were used to analyze data statistically. Age, land holding and livestock possession were found to be highly significantly correlated with participation in livestock management activities.

RESULTS AND DISCUSSION
SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS
Data presented in table 1 depicts that maximum 68.33 percent of respondents belonged to the age group of 31-45 years followed by 20.00 percent belonged to the age group of 46-60 years and only 11.66 percent of respondents belonged to the age group of 18-30 years. Majority of respondents (76.66%) belonged to the backward caste while 21.66 percent were from schedule caste and only 1.66 percent respondent’s belonged to general caste. 55.83 percent of respondents were illiterate and 30.00 percent had education up to primary school level. Regarding family structure more than half of the (53.33%) were from the joint family and rest 46.66 percent belonged to the nuclear family.

Table 1. Distribution of the respondents by their Socio -Economic Characteristics.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Socio-Economic Characteristics</th>
<th>F</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age (year)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18-30 years</td>
<td>14</td>
<td>11.66</td>
</tr>
<tr>
<td></td>
<td>31-45 years</td>
<td>82</td>
<td>68.33</td>
</tr>
<tr>
<td></td>
<td>46-60 years</td>
<td>24</td>
<td>20.00</td>
</tr>
<tr>
<td>2</td>
<td>Caste</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General</td>
<td>2</td>
<td>1.66</td>
</tr>
<tr>
<td></td>
<td>OBC</td>
<td>92</td>
<td>76.66</td>
</tr>
<tr>
<td></td>
<td>SC/ST</td>
<td>26</td>
<td>21.66</td>
</tr>
<tr>
<td>3</td>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Illiterate</td>
<td>67</td>
<td>55.83</td>
</tr>
<tr>
<td></td>
<td>Up to primary</td>
<td>36</td>
<td>30.00</td>
</tr>
<tr>
<td></td>
<td>Middle school</td>
<td>13</td>
<td>10.83</td>
</tr>
<tr>
<td></td>
<td>High school</td>
<td>4</td>
<td>3.33</td>
</tr>
<tr>
<td>4</td>
<td>Family type</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nuclear</td>
<td>56</td>
<td>46.66</td>
</tr>
<tr>
<td></td>
<td>Joint</td>
<td>64</td>
<td>53.33</td>
</tr>
<tr>
<td>5</td>
<td>Family occupation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agriculture</td>
<td>82</td>
<td>68.33</td>
</tr>
<tr>
<td></td>
<td>Service</td>
<td>11</td>
<td>9.16</td>
</tr>
<tr>
<td></td>
<td>Business</td>
<td>27</td>
<td>22.50</td>
</tr>
<tr>
<td></td>
<td>Daily wage earner</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>6</td>
<td>Land holding</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 to 2.5 acre</td>
<td>77</td>
<td>64.16</td>
</tr>
<tr>
<td></td>
<td>2.6 to 5 acre</td>
<td>29</td>
<td>24.16</td>
</tr>
<tr>
<td></td>
<td>5.1 to 7.5 acre</td>
<td>13</td>
<td>10.83</td>
</tr>
<tr>
<td></td>
<td>Above to 7.5 acre</td>
<td>1</td>
<td>0.83</td>
</tr>
</tbody>
</table>
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| 7 | Annual Income | Low (below Rs 10,00) | 0 | 0.00 |
|   | Medium (Rs 10,000-30,000) | 99 | 82.5 |
|   | High (above Rs 30,000) | 21 | 17.5 |

| 8 | Livestock Ownership | Small herd size | 0 | 0.0 |
|   | Marginal herd size | 104 | 86.66 |
|   | Large herd size | 16 | 13.33 |

Agriculture was the main occupation of majority of the respondents (68.33%) while service and business were the main occupation of 9.16–22.5 percent respondents and rearing of cattle were subsidiary occupation of majority of the respondents. With regard to land holding maximum 64.16 percent respondents possessed 1 to 2.5 acre followed by 24.16 percent had land holding from 2.6 to 5 acre and only 10.83 percent had land holding 5.1 to 7.5 acre. Majority of the respondents (82.5%) had annual income from 10,000-30,000 followed by 17.5 percent respondents had high annual income. Majority of the respondents (86.66%) had medium herd size and 13.33 percent of them large herd size animals.

PARTICIPATION OF RURAL WOMEN IN LIVESTOCK ACTIVITIES-

The study was focused mainly on five major operations of livestock management. The findings of the study were depicted in table2.

Folder management: – Data presented in table 2 that feeding of animals was female dominated activity in which 69.16 percent women individually or with the support of female 10.83% participated. The MWS is 3.75 also reflects the high participation of women. The male support was obtained in 25.83 - 56.66 percent of the families in procuring of folder, grazing of animal, Storage and growing of folder on enquiring from them it was revealed that growing of fodder and grazing of animal were usually the responsibility of men folk. Similar observation was reported by Rathod et. al. (2011), Vashishtha (2007) who revealed that most of the work related to feeding of cattle and preparation of cattle feed were performed independently by women.

Regarding health care and breeding:-

The health care of animals was solely performed by the respondents. The study shows that the rural women were found to be independently responsible for care of sick animals (45.83%), care of livestock (35.0%) and breeding of animal (18.94%). The MWS of 3.33 reflects high level participation of women in their activity. The male support was found maximum in breading of animal (37.89%) whereas (69.47%) did not participated in breeding of animals. The reason for such findings might be obvious that whenever animal fall sick the common care and providing them general medicine or first aid is done by women folk, whereas during severe illness for veterinary services and taking animals to hospital is being done by men. Rural women were not performing most of the activities related to breeding of animal production. This might be due to less mobility, lack of skill and scientific knowledge, lack of information about veterinary treatment of the animals and social mores and taboos prevalent in the society similar observations were reported by AICRP (2011) and Jamal (1994) indicate that performance of women in breeding and health care activities was either very low or low respectively.
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Table 2. Distribution of respondents by their participation in livestock management activities.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Activities</th>
<th>I</th>
<th>JF</th>
<th>JM</th>
<th>NP</th>
<th>MWS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>%</td>
<td>F</td>
<td>%</td>
<td>F</td>
</tr>
<tr>
<td>1.</td>
<td>Fodder Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Growing of fodder (n=90)</td>
<td>28</td>
<td>31.11</td>
<td>8</td>
<td>8.88</td>
<td>51</td>
</tr>
<tr>
<td>B</td>
<td>Procuring of fodder (n=120)</td>
<td>44</td>
<td>36.66</td>
<td>24</td>
<td>20.0</td>
<td>31</td>
</tr>
<tr>
<td>C</td>
<td>Storage of fodder (n=120)</td>
<td>58</td>
<td>48.33</td>
<td>9</td>
<td>7.5</td>
<td>45</td>
</tr>
<tr>
<td>D</td>
<td>Feeding of animal (n=120)</td>
<td>83</td>
<td>69.16</td>
<td>13</td>
<td>10.83</td>
<td>24</td>
</tr>
<tr>
<td>E</td>
<td>Gazing of animal (n=90)</td>
<td>37</td>
<td>41.11</td>
<td>0</td>
<td>0.00</td>
<td>29</td>
</tr>
<tr>
<td>2.</td>
<td>Health Care and Breading</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Care of livestock (n=120)</td>
<td>42</td>
<td>35.00</td>
<td>44</td>
<td>36.66</td>
<td>31</td>
</tr>
<tr>
<td>B</td>
<td>Care of Sick animal (n=120)</td>
<td>55</td>
<td>45.83</td>
<td>30</td>
<td>25.00</td>
<td>35</td>
</tr>
<tr>
<td>C</td>
<td>Breading of animal (n=195)</td>
<td>18</td>
<td>18.94</td>
<td>0</td>
<td>0.00</td>
<td>20</td>
</tr>
<tr>
<td>3.</td>
<td>Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Cattle shed management (n=120)</td>
<td>58</td>
<td>48.33</td>
<td>27</td>
<td>22.5</td>
<td>24</td>
</tr>
<tr>
<td>B</td>
<td>Excreta management (n=120)</td>
<td>74</td>
<td>61.66</td>
<td>18</td>
<td>15.0</td>
<td>28</td>
</tr>
<tr>
<td>C</td>
<td>Engagement of labour (n=30)</td>
<td>10</td>
<td>33.33</td>
<td>0</td>
<td>0.00</td>
<td>20</td>
</tr>
<tr>
<td>4.</td>
<td>Processing and Marketing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Processing of produce (n=120)</td>
<td>69</td>
<td>57.5</td>
<td>33</td>
<td>27.50</td>
<td>18</td>
</tr>
<tr>
<td>B</td>
<td>Retention of produce at household level (n=120)</td>
<td>72</td>
<td>60.00</td>
<td>48</td>
<td>40.00</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>Marketing of produce (n=95)</td>
<td>64</td>
<td>67.36</td>
<td>14</td>
<td>14.73</td>
<td>8</td>
</tr>
<tr>
<td>5.</td>
<td>Financial activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Management of revenue earned from sale of produce (n=95)</td>
<td>30</td>
<td>31.57</td>
<td>13</td>
<td>13.68</td>
<td>24</td>
</tr>
<tr>
<td>B</td>
<td>Credit/Loan (n=45)</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>24</td>
</tr>
<tr>
<td>I</td>
<td>Sauce of processing</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>20</td>
</tr>
<tr>
<td>II</td>
<td>Amount of processing</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>20</td>
</tr>
<tr>
<td>III</td>
<td>Amount of repaying</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>20</td>
</tr>
<tr>
<td>IV</td>
<td>Mode of repaying</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 2. Distribution of respondents by their participation in livestock management activities.
I - Independent    JF- Joint with female    JM- Joint with male    NP- No participation    MWS- Mean Weighted Score

(55)
Management: - The next major activity where women participated activity was management of livestock resources. According to table 2 cattle shed and excreta management (both fresh and processed) were the activities performed by majority of the respondents independently (48.33 - 61.66%) and their MWS were 3.33 - 3.75 that further confirm the findings. On enquiring from them it was revealed that cattle shed and excreta management was the principle responsibility of rural female. Maximum (66.66%) of respondents engaged labour activity in livestock management. The engagement of labour activity by 90 families was not done. The reasons behind this might be due to high cost of labour and labour scarcity in the study area Rathod, et. al. (2011) also revealed that women (86.66 – 90.00%) performed activities like milking, cleaning of animal shed, disposal of cow dung or preparation of cow dung cakes and similar observation were reported by Jain et. al. (2012). 

Processing and Marketing: - In case of processing and marketing respondents participation independently was found to be the maximum (57.5 %) participated with support of the female (27.50 %) and with support of the male (15.00%) in processing of milk and milk products. A majority of them (60.00%) also looked after the processed products at household level independently but their participation in marketing related activities was less as compared to processing activities and their MWS were 2.63. The reason behind low participation of women in marketing activities might be due to illiteracy, less mobility, male dominance and social mores and taboos prevalent in the society similar findings were reposted by Jain et al. (2001) and Rathod et. al. (2011). Who reveled that a majority of farm women were involved in sale of milk and milk products and milk processing activities like butter preparation and ghee making.

Financial activities: - Regarding financial aspects table 2 shows that less than half of the respondents (31.57%) were participating in management of revenue earned from sale of produce independently. The MWS of 2.73 reflects high level participation of women in this activity. The rural women perceived the activities of procuring and repaying of loans/credits as the responsibility of men and hence only 44.45 - 53.33 percent of women were involved in this activity. The reasons behind this might be lack of information about existing financial service, complicated procedure of accessing loans, poor repayment, capacity, consequences of not paying the loan/credit, high interest rates and insecurity etc. all these create a troublesome situation for the women to get credit/loan. The findings of the study get support from Jain et. al. (2012) who revealed that majority of the rural women perceived the activities of getting loans/credits from the banks as responsibility of men and hence only 44.7 percent of them were involved in this activity.
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Relationship of participation in livestock management activities.

Table 3. Correlates of participation in livestock management activities.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Independent Variables</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td>-0.377**</td>
</tr>
<tr>
<td>2</td>
<td>Education</td>
<td>-0.189</td>
</tr>
<tr>
<td>3</td>
<td>Annual Income</td>
<td>-0.182</td>
</tr>
<tr>
<td>4</td>
<td>Land Holding</td>
<td>-0.948**</td>
</tr>
<tr>
<td>5</td>
<td>Live Stock ownership</td>
<td>+0.178**</td>
</tr>
</tbody>
</table>

** Significance at 0.01 level of significance.

It is evident from the table 3 that age, land holding and livestock possession were found to be highly significantly related with participation in livestock management activities. Education and annual income were found to be negatively related. It indicated that these variables did not show any relationship with participation in livestock management practices. Age, Education and Land holding were found to be negatively correlated. It means more the age lesser the involvement, similarly higher the education lowers the participation in livestock activities. The probable reason may be educated women consider these activities below dignity and prefer their involvement in other sectors. On the other hand, larger the land holding, the participation in livestock rearing was found to be lesser; the problem reason may be because of shifting to other subsidiary accusation.

CONCLUSION

It can be concluded that women were playing crucial roles in most of the livestock management activities more than their counterpart and have proved that they work in livestock management in a better way than men since they had more affection and care with livestock, but due to ignorance they may be lacking knowledge to use the technologies that can be simplify their work in livestock management. There is thus an urgent need to educate women about livestock technologies and scientific management practices for increasing livestock production and management. Rural women have to be motivated and need to be trained in livestock management practices based on scientific recommendation for better prospect of livestock rearing.

REFERENCES

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PARENTAL CARE IN FISH AND ITS MECHANISM

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Division of Aquaculture. ICAR- Central Institute of Fisheries Education, Mumbai

INTRODUCTION

Parental care is an inborn behavior of some fishes which is a type of investment for the young ones by their parents for defending them against predators or to supply more oxygen, keeping the egg moist, etc. Parental investment mainly depends on the degree of confidence of paternity, capabilities of the parents after mating, availability of the mates, etc. This parental investment also varied with sex like paternal care, maternal care, bi-parental care or multi parental care and also with the time of care like care during egg incubation or during spawning after fertilization of the eggs. The parental investment helps in the healthy and mass recovery of young ones from mortality.

FORMS OF PARENTAL CARE IN FISHES

BUBBLE NEST FORMATION: Bubble nest formation is done mainly by the male Siamese fighting fish, Dwarf gourami like fishes of Anabantidae. Bubble nests are also called as foam nest which are formed by the mucus-lined bubbles. Fish that build and guard bubble nests are known as aphrophils. Aphrophils include gouramis (including Betta species) and the synbranchid eel Monopterus alba found mainly in Asia, Ctenopoma (Anabantidae), Polycentropsis (Nandidae) and Hepsetus odoe (the only member of Hepsetidae) in Africa and callichthyines and the electric eel in South America.

Bubble nest formed by Betta sp.
VEGETATIVE NEST FORMATION

The male three-spined sticklebacks, *Gasterosteus aculeatus*, makes vegetative egg nests by the glue from the special kidney protein spiggin. Nest-building glue suppressed microbial activity and appeared to enhance reproductive success. Thus, in addition to containing structural proteins important for the construction of nests, *G. aculeatus* glue could be a mechanism by which males protect their off-spring from pathogens (Knouft et al., 2003).

Similar parental care has also been reported in India during the breeding of greenhead spotted murrel, *Channa punctata*, where the male guards the nest and the female remained inside the nest along with the fry. In case of *Channa striatus*, female has been seen to be more aggressive than the male. Surprisingly when both the fishes are induced bred through different hormones, no parental care has been observed.

MOUTH BROODERS

MOUTH BROODING is also called as oral incubation or buccal incubation. It is the care towards some the offsprings shown by their parents by holding them in the mouth for extended periods of time. Some commercially important fish are mouth brooders, most common are the Tilapiines and Arowanas. Harvesting of offsprings may be done by an official to certify that the fish farm as a genuine producer of captive-bred fish if it is an endangered species, such as Asian arowana.
FANNING AND BROODING
It has shown by Center of Advanced Study in Marine Biology, Tamilnadu that increased fanning time not only increases the hatching success of clown fish but also fanning frequency play same role in parental care. It has also been revealed that fanning also acts as a major physiological function of these species for their hatching success and the health of the young ones.

Similarly discus fish also shows parental care by providing mucus as spoon-feed for the young ones. The analysis of mucus revealed that parents provides offspring with an initial high quantity of nutritional and non-nutritional factors including antibodies (IgM), essential ions and hormones. Behavioral studies also revealed that initially parents were highly diligent in providing care to offspring but that after two weeks of care, the behavior of parents changed making it harder for offspring to obtain mucus. At this point a weaning period was initiated where offspring began spending less time with parents and more time foraging for external food sources.

DEFFENCE
This type of parental care is mostly seen in fishes, where the male takes care of the eggs and the young ones. In fishes like sticklebacks, damselfish, girabali, bluegill sunfish, plainfin midshipman, and the black-chinned tilapia, males compete for territories; construct nests, and court females.

ALLOPARENTAL CARE
Trivers (1972), considered parental care in his definition of parental investment defined as “Any investment by the parent in an individual offspring that increases the offspring’s chance of surviving (and hence reproductive success) at the cost of the parent’s ability to invest in other offspring”. Alloparental care is care directed at non-descendant young. Alloparental care incurs the costs of conventional care
without necessarily providing a fitness benefit. In some cases, alloparental care is indeed the outcome of a parasitic act by conspecifics or heterospecifics. The term Alloparent can also be defined as “allo” means others in Greek and “paren” means Parents in Latin. So Alloparenting can be defined as prenting the offsprings by the other-parents. It can be allomaternal and allopatal. The term “alloparental care” is first used by Edward O. Wilson in 1975, in his book Sociobiology to define relationship like ‘uncle’, ‘auntie’.

The most common alloparenting evidence has been seen in case of fisheries are like the 'Babysitting' in sperm whales and Interspecific brood amalgamation seen in catfish (Bagrus meridionalis) broods who give care to the cichilid young in Lake Malawi.

Alloparental care of eggs
- Sperm dumping
- Egg dumping
- Zygote dumping
- Nest take-overs
- Zygote stealing

Alloparental care of free-swimming young
- Extension of alloparental care of eggs
- Independent offspring inclusion
- Young dumping (farming out)
- Kidnapping
- Brood amalgamation
- Philopatric offspring

Hormonal regulation in parental care
Research in cichlids suggests that the oral egg carrying behaviors is promoted by a combination of PRL (Prolactin) and oestrogen. Work indicates that pituitary tiPRL177 concentrations increase in female Mozambique tilapia brooding eggs or early stage embryos as well as in the serum concentrations of tiPRL177 also increasing in females brooding late-stage larvae (Weber and Grau, 1999). In case of nest builders also there is evidence to suggest that mucous production associated with nest construction is under the control of PRL. Experimental administration of PRL increases mucous production and stimulates increased numbers of mucous cells and nest building behavior in paradisefish (Macropodus opercularis) (Machemer, 1971; Machemer and Fiedler, 1965). An early experiment showed the administration of PRL increase the fanning behavior in male and female angelfish (Pterophyllum scalare) and brown discus (Symphysodon haraldii), even in the absence of eggs (Blüm and Fiedler, 1964,
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1965). This increased activity was found to be dose-dependent, and higher doses of PRL inhibit fanning behavior. PRL also induces fanning in other species of fish, including wrasse males (\textit{Symphodus ocellatus}) [Blüm and Fiedler (1965)] and stickleback males (Pall \textit{et al.}, 2004). Experimental treatment of Convict cichlid (\textit{Amatitlania nigrofasciata}) females and male bluegills (\textit{Lepomis macrochirus}) with PRL inhibitors results in decreased fanning behaviour [Hoar \textit{et al.} (1983), Kindler \textit{et al.} (1991)]. In the case of pit digging by blue acara (\textit{Andinoacara pulcher}) where the PRL has role in the digging process (Blüm, 1966). The role of PRL is well documented for guarding of schooling fry, nest guarding, defense, mouth brooding, and feed inhibition by the brood. Male caring fishes like damsel fishes have high plasma androgen levels (testosterone and 11-ketotestosterone) during pre-spawning, when males compete for territories, construct nests, and court females. The androgen levels then gradually drop following spawning while males provide care. This is believed to indicate an androgen-mediated trade-off between aggression and parental care and a minimal role of androgens during parental care. However, recent studies show that androgen levels often rise again to pre-spawning levels once eggs have hatched. But in case of alloparental daffodil cichlid (\textit{Neolamprologus pulcher}) the PRL has no effect in the parental care. Females providing brood care have lower PRL mRNA levels than non-brooding females (Bender \textit{et al.}, 2008). The androgen has major role in these cichilids which controls their frequency of parental care as well as defending the young ones.

CONCLUSION

The nature’s strategy is so crucial that the evolution of parental care came into existence for the high survival of offspring. So by finding the information on feeding and the breeding ground of these highly evolved fishes in natural condition will provide best direction for their study on behavior as well as in captive condition there is a huge scope for the study of changes in behavior in different factors with respect to different season. In existence to the earlier record, the future study on the species may provide an opportunity to know the hormonal effect of physiological response on parental care of fishes.

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Notes:
- Parental care is one of the strategy of nature for the healthy and high survibility of young ones.
- More research should be done for studying the mechanism of parental care.
- The physiology behind alloparental care is to be studied properly.
- If artificially parental care can be induced, then it can be beneficial to enhance the larval survibility of the fishes.
EFFECTS OF APPLICATION OF SEWAGE SLUDGE IN AGRO-ECOSYSTEMS

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ABSTRACT

World’s increasing wealth as well as economic and social development have brought waste to the forefront of discussion. The way in which waste – sewage sludge included – is collected, processed, recycled and disposed off affects the quality of life of every one of us, and the quality of the environment around us. These are the reasons why there is a great needed of reckoning sewage sludge to ensure that waste is dealt with properly and in an environmental friendly fashion. The agricultural sector needs a secure, long term supply of nutrients and organic matter (humus) to compensate for losses through harvest, grazing and leakage into surface water, groundwater and the atmosphere. Application of sewage sludge in agriculture provides an opportunity to recycle plant essential nutrients (N, P, secondary nutrients and micronutrients) and improves soil physical, chemical and biological properties due to high organic matter content. In this article, an attempt is made to review the available information on various aspects of land application of municipal sewage sludge on crop yield, soil fertility and problems of heavy metals accumulation in edible portion of the crops as well as possible options for remediation of heavy metals toxicity in contaminated soils to explore the possibility of safe recycling of this waste in agriculture.

INTRODUCTION

Sewage sludge, also known as biosolids, is comprised by biological insoluble residues of municipal wastewater treatment produced either after aerobic or after anaerobic digestion processes. It is a very complicated heterogeneous substrate consisting of organic materials, bacteria, inorganic particles, and colloids. It is an unhidden fact that it contains appreciable amount of organic matter, phosphorus, nitrogen and microelements. The significant increase in the production of sewage sludge in recent years due to the rapid development of industrial and economic activities as well as escalating growth of urban populations (Shao et al. 2015) has raised serious concerns of its disposal and management.

On a global scale, the safe disposal as well as recycling of the sewage sludge has become one of the major environmental concerns. Currently, the principle means of sewage sludge disposal is by the processes namely incineration, landfilling, and it has also found some applications in the agroecosystems (Fytili and Zabaniotou 2008). Among above mentioned means, agricultural application cum environmental usage of SS is the most economically viable, environmentally sustainable and preferred method (Kacprzak et al. 2017; Bravo-Martín-Consuegra et al., 2015). Undoubtedly, it contains appreciable content of organic matter (OM), nitrogen (N), phosphorus
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(P), potassium (K) and other microelements (Herzel et al. 2015; Rigby et al. 2015), which can significantly enhance plant growth and development (Grobelak et al. 2017). In Belgium, Denmark, Spain, France, Ireland, and the United Kingdom, more than 50% of SS has found usage in agricultural systems in 2010 (Kacprzak et al. 2017). Although the disposal of sewage sludge is a matter of great concern but several studies have also revealed the beneficial aspects of its application in the agricultural systems.

Effect on Soil Properties

The conventional agricultural systems have largely focused on the application of farm manure as the primary organic amendment which is meant especially for the restoration of soil fertility. Additionally, it also acts as a tool for improving the physico-chemical properties of the soil (Lakhdar et al., 2010). Conversely, the hike in the prices of farm manure along with its reduced availability has arisen the quest for its potential alternative. Therefore, the sewage sludge has been nudged as a substitute for the recycling and for the enhancing the soil fertility at nominal costs (Zoghlami et al., 2016). It has been observed that the optimal land application improves soil fertility, as well as crop yield (Roig et al., 2012; Özyazici, 2013; Poulsen et al., 2013). The application of sludge results in the augmented nutrient status as assessed by the TOC, N, P and K content of the soil (Hamdi et al., 2019; Tontti et al., 2017).

With regard to soil physico-chemical properties, soil application of sewage sludge augments the soil organic matter content which in turn increases the amount of available moisture in rootzone (Shao-Hua et al., 2012; Andry et al., 2012). The application of sewage sludge not only increases the water retention properties of the soil but also the volume of pores with diameters below 50 μm (Głąb et al., 2018). The amendments of soil with the sewage sludge results in improved physicochemical properties by decreasing bulk density, electric conductivity, pH, and increasing soil organic carbon, >0.25 mm water-stable aggregate fraction, cation exchange capacity, nitrogen, and phosphorus contents (Zuo et al., 2019). The long term use of SS also proves to be efficient in entirely replacing P fertilization and micronutrients (Melo et al., 2018). Furthermore, it also results in the modifications in the chemical properties of soil such as increased soil organic carbon, total and available N and P, and decrease in soil salinity and pH (Bai et al., 2017).

Effect on Phytoremediation

The better quality of soil is of supreme importance for life. In addition to plant growth, it act as a filter for surface and underground water, habitat for soil animals and soil microbes – the latter are of utmost use for equilibrating the exchange of especially C and N components. There is a continuous decline in the soil fertility status and it is indeed an arduous task to reinstate the productive capacity of soil (Evans et al., 2014; Wu et al., 2010). Because of anthropogenic impact, the existence of living beings on this lithosphere is being endlessly affected. Hence, a gamut of activities like industrial, transportation, atmospheric deposition, use of waste products and waste water adds up significant amount of pollutant concentration in the environment like
metals. Such elevated concentration in the lithosphere results into hazardous consequences (Smolders et al., 2009). Numerous measures are opted for the remediation of metal contaminated soils but most of them are complicated to be used on such vast contaminated areas (Kidd et al., 2009; Padmavathamma and Li, 2007). The biological methods proved to be the most effective to phytostabilize the soil containing toxic environmental contaminants. Moreover, phytostabilization can be assisted by the application of sewage sludge which contributes to the process of phytoremediation. Phytoremediation is a cost-effective plant-based approach of remediation that utilizes the ability of green plants and the associated micro-organisms to render harmful environmental contaminants harmless (Jabeen et al., 2009). Mainly non-edible plants like ornamental (Chu et al., 2017) and bioenergy crops (Pulford et al., 2002; Antonkiewicz et al., 2016; Wyrwicka and Urbaniak, 2018) or forest species (Grobelak et al., 2017), are used to stabilize pollutants (organic and inorganic) present in the soil (Cristaldi et al., 2017), municipal wastewater (Guidinissim et al., 2015) and groundwater (Guidinissim et al., 2014).

The plant root prevents soil erosion as well as reduces the leaching of heavy metals to the surface and ground-water environment (Brunner et al., 2008; Pulford and Dickinson, 2006). The sewage sludge enhance establishment of plant growth by providing soil organic matter (SOM) which makes plant available with essential plant nutrients. Furthermore, it increases soil water holding capacity and cation exchange capacity (CEC). The high CEC can significantly reduce the concentration of bioavailable heavy metals by complexation (Hashimoto et al., 2008). However, the results showed that the gradual release of macronutrients from sewage sludge were fully utilized by plants to stimulate their growth and development. The content of heavy metals in plant biomass was much lower and were mainly accumulated in roots (Grobelak et al. 2017).

**Effect on Microbial Diversity**

The fertility of soil is comprised by the three interrelated components: physical fertility, chemical fertility and biological fertility. The latter is essential for the maintenance of biodiversity above and below ground. The wealth of biodiversity below ground is vast and unappreciated. Millions of microorganisms live and reproduce in a few grams of topsoil, an ecosystem essential for life on earth. Most of the research has focused on addition of organic material back to the soils to restore its fertility. This is an important strategy, but before that there is a great need to enhance the soil microbes that are responsible for its high quality and other ecological processes (Gonzalez-Quiñones et al., 2011). The soil microbial parameters such as activities, biomass and soil microbial diversity are good and responsive indicators for soil quality (Tarraşón et al., 2010; Epelde et al., 2010), due to their sensitivity, fast response and ecological relevance (Barrutia et al., 2011; Pardo et al., 2014). Soil enzymes are prime factors in nutrient cycling and can be used to detect changes in the microbial community derived from soil management, e.g. organic waste application. The utilization of sewage sludge in agriculture or for reclamation can be reckoned as the most preferred method of its safe disposal, recycling and to boost the soil quality with organic matter and nutrients (Water UK, 2010). It is found that the all the soil enzymes responded positively to sludge application, most abundant soil bacteria (Siebielec et al.,
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2018., Fijałkowski and Kacprzak, 2009), even when applied at the reclamation rates. Arif et al., 2018 reported a more pronounced stimulation of soil microbial biomass by application of sewage sludge in degraded soils i.e. low in organic matter. Moreover, sewage sludge is well-known to boost the growth, biomass, reproduction and population density of earthworms (Barrera et al., 2001; Emmerling and Paulsch, 2001; Rorat et al., 2013).

**Effect on accumulation and bio-availability of heavy metals:**

A great deal of time has been spent in seeking the management of sewage sludge, especially targeting the presence of heavy metals in it (Smith, 1996). Heavy metals content in sewage sludge is one of the vital criteria that determine its environmental use. Its application to soils knocks ample controversies, even if the standards of the HMs content are met. The continuous application of sewage sludge begins to an increased level of HMs in soils (Alloway and Jackson, 1991; Bai et al., 2017; Charlton et al., 2016). The subsequent addition also leads to potential aggregation of HMs in flora and soil fauna as well as causes surface and ground water contamination. The mobility and release of HMs from the sewage sludge depends on the chemical forms, which gets affected over time due to changes in sewage sludge composition.

The combined application of sewage sludge with carbon adsorbents seems to be assured solutions where metals firmly bind to the adsorbents (Frišták and Soja, 2015a; Liang et al., 2012; Su and Wong, 2004; Usman et al., 2005). The latter, enhances the immobilization of the metals in soil, which results in the abatement of their mobility and bioavailability. It is imperative not only that the added adsorbent should have long term effect but should be neutral to the environment as well as have affirmative influence on soil. Furthermore, it is found that the application of sewage sludge with biochar at an appropriate rate improves soil physical, chemical and biological properties, particularly in poor quality soils (Al-Wabel et al., 2017; Igalavithana et al., 2016). Thus, such a win-win solution not only allows the bioavailability of HMs to be effectively reduced in soils but also increases soil fertility as sewage sludge is rich in organic matter and nutrients (Ali et al., 2017; Karer et al., 2017; Suciu et al., 2015). In addition to this, immobilization of the bioavailable fraction of polycyclic aromatic hydrocarbons (PAHs) (Oleszczuk et al., 2012; Stefaniuk and Oleszczuk, 2016) and degradation of organic contaminants present in sewage sludge carried out by this combination (Stefaniuk et al., 2017).

The application of Sewage sludge into the soil resulted in an increased soil content of mobile forms of Ni and Zn but studies demonstrated that biochar significantly immobilized the content of Ni and Zn in sewage sludge which leads to a further decline in the environmental risk related to their presence in the environment (Bogusz, A., & Oleszczuk, P. 2018). The studies of other authors (Frišták and Soja, 2015a) showed that the application of biochar in combination with sewage sludge used as a soil amendment increased the content of available forms of phosphorus and reduced the leaching of nutrients (Kończak, M., & Oleszczuk, P. 2018), thus contributing to reduced risk of eutrophication of water bodies.
CONCLUSION AND FUTURE PROSPECTS

The concept of generating wealth from waste is gaining importance day by day. Sewage sludge comprised by biological insoluble residues of municipal wastewater treatment is facing a great challenge of its disposal. The process of urbanization has contributed more towards the generation of sewage sludge. Although it can find applications in agroecosystems and is found to enhance the properties of the soil but the heavy metal content of sewage sludge has always been a matter of controversies. The sewage sludge also affects the native microbial diversity of the soil and is also found to effect other processes like phytoremediation and nutrient cycling. The immobilization of heavy metals in the sewage sludge can prove to be an effective strategy in promoting its agricultural application. Moreover the pathogens present in the sewage sludge should also be screened for their possible effect on agroecosystems. Thus the judicial employment of sewage sludge in the agroecosystems can be efficacious to enhance the produce.

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ROLE OF WOMEN IN AGRICULTURE

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INTRODUCTION

Women play a significant role in crop production and allied fields like the horticulture, post harvest operations, agro/social forestry, fisheries, livestock production, etc. Statistics of India confirm the representation of women in agriculture as significant. The proportion of women in agricultural production and post harvest activities ranges from 20 to 70%; their involvement is increasing in many developing countries, particularly with the development of export-oriented irrigated farming, which is associated with a growing demand for female labour, including migrant workers. In spite of all this, it is unfortunate that because of centuries of inertia, ignorance and conservatism, the actual and potential role of women in the society has been ignored, preventing them from making their rightful contribution to social progress. It is also because of distorted and partial information about their involvement in agriculture and consequent devaluation of their contribution that they are denied their rightful status as active producers in agriculture and access to developmental resources and services contributing to their marginalisation. Women must be empowered by enhancing their awareness, knowledge, skills and technology use and efficiency so that agricultural production multiplies at a faster pace, environmental degradation is reduced and conservation of resources is practised earnestly, thereby, facilitating overall development of the society.

Empowerment in the context of women’s development is a way of defining, challenging and overcoming barriers in a woman’s life through which she increases her ability to shape her life and environment. It is an active, multidimensional process which should enable women to realise their full identity and power in all spheres of life. Since time immemorial, women have played, and continue to play, a key role in conservation of basic life support system, such as, land, water, flora and fauna. Rural women play a crucial role in agricultural development and allied fields, including crop production, livestock production, horticulture, post-harvest operations, fisheries, etc. Without total intellectual and physical participation of women, it is not possible to achieve the goals of rural upliftment. All this signifies the importance of having a full understanding of the role and contribution of farm women so that the extension services may accordingly be devised and geared to fully integrate them in agriculture by better serving their specific needs and interests. It is the concern for their integration in the process of agricultural development, which has today become instrumental for policy debates, research initiative and organisational efforts from women’s perspective. Secretary Clinton described a woman farmer’s typical
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circumstances this way: “She lives in a rural village and farms a piece of land that she does not own. She rises before dawn and walks miles to collect water–if there is water to be found. She works all day in a field, sometimes with a baby on her back. If she’s lucky, drought, blight or pests don’t destroy her crops and she raises enough to feed her family–and maybe has some left over to sell. But there’s no road to the nearest market.” Moreover, her work is not counted in many economies “as economically active employment.”

Time-use surveys that cover all agricultural activities reveal considerable variation across countries and sometimes within countries. In Asia, estimates of time spent range from 32 per cent in India to over 50 per cent in China. A striking degree of within-country variation is shown by time-use data for India. While the nationally representative data indicates that the national average for women’s share of total time-use in agriculture is 32 per cent, data for West Bengal and Rajasthan reports women’s share as from less than 10 per cent to more than 40 per cent, respectively. But in both areas, younger women contribute a higher share of the total time provided in agriculture by their age group than older women. In Rajasthan, for example, girls between 14 and 19 years of age contribute up to 60 per cent of the total time spent on agriculture by their age group. An average, a woman spends 14 hours a day working in and outside the home. During harvesting season she spends about 16 hours a day. Time-use studies also reveal that female time-use in agriculture varies widely depending on the crop and the phase of the production cycle, the age and ethnic group in question, the type of activity and other factors.

PREFERENCE OF WOMEN IN AGRICULTURE FIELD
Agriculture is central to economic growth when women can learn the best way to grow and cultivate their own nutritious food, they can feed their children and sell at markets. So closing the gender gap in agriculture is an imperative if we want to grow productivity and ensure food security—as I know we all do. Governments and stakeholders need to invest in women farmers—who shoulder a significant proportion of agricultural work in the developing world–so they can become more productive. It is generally seen that women from socially forward communities are not preferred to work on their own farm as well as other’s farms. Only in exceptional circumstances they work on their own farm as well as other’s farm. But women from scheduled caste and scheduled tribes have no such reservation and work on their own farms and farms of other farmers.

WOMEN IN DECISION MAKING
In Indian Society both husband and wife participate in different household activities. Their role are generally complementary not only in physical participation in farm but also in the decision making process concerning major land use activities. She influences the farmer in selection of crop, developing the farm with irrigation and other facilities, adoption of latest technologies, timely harvesting, assisting the farmer in post harvesting and storage, timely marketing of the produce and in savings for the future. Inspite of all these, women are not given proper attention. But the globalization has provided many ways and means for the overall development and
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empowerment of women. Women influence the farmer in many ways. She influences the farmer in selection of crop, developing the farm with irrigation and other facilities, adoption of latest technologies, timely harvesting, assisting the farmer in post harvesting and storage, timely marketing of the produce and in savings for the future. Inspite of all these, women are not given proper attention. But the globalization has provided many ways and means for the overall development and empowerment of women. For sustainable food security and development women empowerment is crucial in the present situation.

The decision making process is an important segment of every individual for success of any plan or programme in better way. Women’s role in agricultural operation and allied sector is quite significant. But study on decision making patterns showed that the major decision makers in agricultural activities were men even though women performed more in agricultural related activities than men. This is because of the majority of women are illiterate, have little time to know about the latest techniques of farming and restricted mobility due to several cultural values. Generally, women have less access to information about technology by virtue of their poor educational status and relative isolation from public life. Thus, there is a hesitation to come out and interact. At times, even the suggestions of knowledgeable rural women are ignored or are not taken seriously because men consider it disgraceful to accept the decision of women.

**DRUDGERY IN VARIOUS AGRICULTURAL OPERATIONS**

- Hard physical work in care and management, harvesting, threshing/processing, marketing and bartering of produce.
- Child bearing and rearing simultaneously.
- Remain for a long time under rain and scorching sun.
- Harvesting by bending.
- Weeding with conventional implements by hand in hot sun, rain and cold for long hours.
- Dehusking/shelling, pounding, grinding of cereals and pulses by hand, etc.
- Collecting and carrying fuel over long distance.
- Fetching of water for cooking and drinking from distant places.

**OCCUPATIONAL HEALTH HAZARDS DUE TO DRUDGERY IN AGRICULTURE**

The largest proportion of rural women worldwide continues to face deteriorating health and work conditions, limited access to education and control over natural resources, insecure employment and low income. This situation is due to a variety of factors, including the growing competition on agricultural markets which increases the demand for flexible and cheap labour, growing pressure on conflicts over natural resources, the diminishing support by governments for small-scale farms and the reallocation of economic resources in favour of large agro enterprises. Other factors include increasing exposure to risks related to natural disasters and environmental changes, worsening access to water, increasing occupational and health risks.
The occupational health problems may be mainly due to two reasons, i.e., the use of harmful chemicals in the occupation and the biomechanical and postural demand of the workplace leading to muscular-skeletal disorders. The muscular-skeletal disorder is of very high concern of the Ergonomists. The risk of developing muscular-skeletal problems is mainly due to the inconvenient work postures. This risk of muscular-skeletal disorders may be higher in agricultural workers than in most other industries because of the longer working hours. Uncertainties of agricultural production make farming a relatively stressful job anyway, then people employed in agriculture may be even more vulnerable to muscular-skeletal disorders (O’Neill, 2004).

Muscular-skeletal disorder is the leading cause of the occupational ill health. An awkward and static posture has been recognized as a risk factor for work related muscular-skeletal problems. From an occupational point of view, the cervical spine, head and shoulders, elbow and wrist joint can be considered to be interrelated as far as the problems of efficiency, design and comfort are considered. It is well known that certain jobs causes’ pain at the work to the people with disorder and the symptoms are amplified or exposed by the demands of the job. Muscular-skeletal pains of these types are said to be work related because it is partially caused by the work conditions. It is clear that poor work place and tool design can increase the discomfort of both the healthy and less fit individuals. The design of tools and workspaces can have a profound effect on the posture of the body and long term exposure to hazardous working conditions which alters the physiological and psychological functions of an individual and produces many types of musculoskeletal problems. In developing countries agricultural activities are expected to cause muscular-skeletal disorders (Nwuba and Kaul, 1986; Nag et al., 1988). But an extensive survey is required to confirm that this is the case and to identify the specific problems and the tasks that are associated with it.

**WOMEN AND MECHANIZATION CONSTRAINTS**

After successful adoption of farm inputs and cultural practices the production and productivity of the agriculture have increased. Tractor power tiller, combine seed sowing machines and threshers have played very significant role in reducing drudgery of women in some states but majority of operations are still being performed manually only due to

1. Maximum implements of agriculture production are developed keeping in view of male farmers.
2. Very few female researchers and technicians are appointed for evaluation of women specific technology.
3. Machinery demonstration can easily be found but its handling procedure is rarely available.

**ROLE OF ICAR**

The research efforts at the ICAR institutes have been tried to relieve the women of the drudgery by providing time and labour saving tools. Vocational trainings are also being
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conducted, to impart skills to undertake different vocations. In extension activities the women is now the centre point and activities are being planned keeping her in view. Several programmes started at the National Centre for Women in Agriculture and Krishi Vigyan Kendras are the right steps in this direction. Many projects were initiated on all aspects of role of women in agriculture as follows:

- Development and testing of extension methods for farm women in Eastern India.
- Standardization of women specific field practices in rice in Orissa.
- Occupational health hazards of farm women in coastal Orissa.
- Identification and evaluation of interactive learning modules for dissemination of homestead technologies.
- Improvement in storage practices of seeds and grains of important crops with women perspective.
- Reducing drudgery of women in agricultural operations through use of improved techniques.
- Empowerment of women in agriculture.
- Involving women in aquaculture is a step towards ensuring economic and nutritional security.
- Krishi Vigyan Kendras trained nearly 0.2 million farm women, girls and women extension workers.
- Self help groups were made and took up income generating steps in home made products, dairy products, bakery products, tailoring/embroidery, goat/buffalo rearing and vermicomposting.
- Innovative marketing outlets developed for Self help groups.
- Five components of AICRP on Home Science moved towards empowerment of rural women.
- Cafeteria for women in agriculture was developed and offered to states to guide the development of new programmes for women in agriculture.

Women while fulfilling their multiple roles namely, reproductive, productive and community work remain engaged long hours and perform monotonous and difficult activities which affect their mental and physical health. Moreover, different factors of drudgery embedded in agriculture operations, post-harvest activities, seasonal stress, and child bearing and rearing responsibility, household chores, health hazards create lots of heavy physical exhaustion and fatigue, mental stress, agony, boredom, and malnourishment. These are the reasons for women’s low productivity and social complexity. This would require the introduction and adoption of labour saving and drudgery reducing technologies and methods to alleviate the sufferings of women in agriculture and domestic works which would enable the rural women to participate more energetically and enthusiastically. Women play a vital role in agriculture production from raising nursery to processing which is more than their male colleagues. They lag behind in using improved tools and machinery and continue performing operations which are full of drudgery.
Our govt. institutions have developed gender specific equipments for crop production to processing which are easily adopted by women but their operational training is limited to the institute area therefore here is need to create awareness and provide training on such technology to the women to reduce the drudgery and promote more active involvement in agriculture.

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MOLECULAR MARKERS THEIR CLASSIFICATION AND APPLICABILITY IN MODERN ERA

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INTRODUCTION
Marker is a piece of DNA molecule that is associated with a certain trait of an organism. Marker is a tag which is tightly linked to a gene, whose inheritance could be easily detected and signpost used as a reference.
The markers are generally of three types:
1. Morphological markers  
2. Biochemical markers  
3. DNA marker or Molecular markers

MORPHOLOGICAL MARKERS:
Morphological markers are also called visible marker i.e. shape, size, colour etc. Morphological markers are generally related to qualitative traits which can be scored visually and these differences are developed by mutation.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{morphological_marker.png}
\caption{Morphological marker}
\end{figure}

BIOCHEMICAL MARKER:
Biochemical markers are based on amino acid banding patterns. They are also known as isozyme markers and useful for breeders. It is based on the migrational property of the protein. Gene that encodes a protein can be extracted and observed for example, isozymes and storage protein.

(81)
Multiple forms of the same enzyme:
Allozyme:- Variant forms of an enzyme that are coded by different allele at the same locus are called allozymes.
Isozyme:- Isozymes (also known as isoenzymes or Multiple forms of enzymes) are enzymes that differ in amino acid sequence but catalyze the same chemical reaction.

MOLECULAR MARKER:
DNA markers first reported during 1980s. In genetics, a molecular marker (identified as genetic marker) is a fragment of DNA that is associated with a certain location within the genome. Molecular markers are used in molecular biology and biotechnology to identify a particular sequence of DNA in a pool of unknown DNA. A molecular marker is a DNA sequence that is readily detected and whose inheritance can easily be monitored. The use of molecular markers is based on naturally occurring DNA polymorphism, which forms the basis for designing plan to exploit for applied purposes.

Molecular marker represents a particular segment of DNA which shows differences at genome level. They are not considered as a normal gene but thought as constant landmark in the genome because they do not have biological effects. The DNA sequence is identifiable which are mainly present at specific location of genome and transmitted from one generation to another. Markers show high level of polymorphism which distributed across the genome and gives genetic variations resolution. The DNA markers or Molecular markers are divided into two categories hybridization based and PCR based technique according their limitation and strengths. These types of markers may also identify dominance and co-dominance within the genome. With the help of marker identifying the heterozygotes from homozygotes within the organism. Co-dominant markers are more beneficial because they identify more than one allele thus enabling someone to follow a particular trait through mapping techniques. These markers allow for the amplification of particular sequence within the genome for comparison and analysis. Molecular markers are effective because they identify an abundance of genetic linkage between identifiable locations within a chromosome and are able to be repeated for verification and small changes within the mapping population enabling distinction between a mapping species, allowing for segregation of traits and identity. They identify particular locations on a chromosome, allowing for physical maps to be created. Lastly they can identify how many alleles an organism has for a particular trait (bi allelic or poly allelic).

Uses
1) DNA markers can be used to study the relationship between inherited diseaseand its genetic causes.
2) DNA markers have to be easily identifiable, associated with a specific locus and highly polymorphic, because homozygotes do not provide any information.
3) There was a debate over what the transmissible agent of CTVT (canine transmissible venereal tumor). Many researchers hypothesized that virus-like particles were responsible for transforming the cell, while others thought that the cell itself was able to infect other canines as an allograft. With the aid of genetic markers, researchers were able to provide conclusive evidence that the cancerous tumor cell evolved into a transmissible parasite. Furthermore, molecular genetic markers were used to resolve the issue of natural transmission, the breed of origin (phylogenetics), and the age of the canine tumor.[3]

4) Genetic markers have also been used to measure the genomic response to selection in livestock. Natural and artificial selection leads to a change in the genetic makeup of the cell. The presence of different alleles due to a distorted segregation at the genetic markers is indicative of the difference between selected and non-selected livestock.[4]

![Figure2: Different Genetic Marker](image)

**RFLP** :- (Restriction fragment length polymorphism)
It is widely used hybridization based molecular marker since 1975 for genetic mapping. For RFLP analysis, DNA sample is broken into pieces or digested by restriction enzymes. The restriction enzyme cut the DNA into small fragment to ensure their length by the gel electrophoresis (TBE buffer solution Tris-borate-EDTA) and transfer them to the Southern Blotting procedure. After that hybridization of the membrane on which the individual fragments are present with the help of labeled probe. The length of the fragment detected between individual by RFLP. This can be used in genetic analysis. RFLP marker is reproducible and very robust. The method RFLP marker is widely used for paternity testing and detection of genetic diseases. Most RFLP marker are co-dominant (both alleles in heterozygous samples will be detected) and highly locus specific. It is reliable marker and widely used in breeding programs.
RFLP ANALYSIS:-

1. Plant Tissues
2. Genomic DNA isolation
3. Digestion of DNA with restriction Enzymes
4. DNA fragment separated on agrose gel
5. Southern blotting
6. Transfer of DNA on nitrocellulose membrane
7. Incubate with suitable probe
8. Southern Hybridization
9. Auto radiography
10. Positive band shows RFLP pattern

RFLP MARKER CONVERTED INTO PCR BASED MARKER

Sequence tagged sites (STS)

STS is mainly based on DNA sequence probe gives a polymorphic band pattern and specific amplicon. Specific primers used in Polymerase chain reaction (PCR) helps in the detection of STSs. They form landmarks of genomic physical map. STS were introduced by Olson et al. (1989). Using this approach hybridization based procedure may not be used. This process has proved useful for studying various species and studying genetic polymorphism. By the virtue of these markers linked to some specific traits, they can easily integrated into plant breeding programs for marker assisted selection of the trait of Interest. STS-based PCR produces simple
and reproducible pattern on agarose or polyacrylamide gel. In most of the cases STS markers are co-dominant.

**PCR based Molecular Markers**
PCR is a versatile technique invented during the mid-1980. By the help of PCR large number of production of specific DNA sequence without cloning using a few molecules of the target sequence. PCR based molecular marker by which amplification have been done such a particular DNA sequence with the help of oligonucleotide sequence (primers) and DNA polymerase enzyme which are thermo-stable in nature. After that these fragments are separated and their banding patterns are analysis by autoradiography. PCR based molecular markers such as (RAPD, AFLP, ISSR, SCAR, SNP).

**Random Amplified Polymorphic DNA Markers (RAPD)**
RAPD markers are DNA fragment of random segments of genomic DNA with single primer arbitrary nucleotide sequence of 10 bp to generate random fragments form template DNA. The isolation of DNA from the genome or gene pool and denatured the template DNA. After that annealing of DNA template with a primer, a complete strand will form. Then the amplified product being separated by gel electrophoresis and identified. The power of RAPD is that it is a fast technique, easy to perform and comparatively cheap. RAPD have different applications involving the detection of DNA sequence polymorphism, mapping in different types of population, isolation of marker linked to various traits or specific targeted intervals and identification of varieties and analysis of parentage. There are no requirements of specific probe species and there is no involvement in blotting or hybridization. RAPD have been used for estimation of genetic diversity in various endangered plants species. RAPD is used in Bulked Segregant Analysis (BSA) because RAPD is multiplex in nature and use only single primer PCR to amplify the DNA fragments. Main advantages of using RAPD marker obtained at reasonable cost and amplify the large number of DNA fragments. By the help of RAPD polymorphic band will be obtained can further cloned for analysis. RAPD is used for population based study.

**Amplified Length Fragments Polymorphism (AFLP)**
AFLP recently used as DNA finger-printing technique. This method is based on PCR amplification. As the name suggested their meaning, that it amplifies the DNA fragment but this is dissimilar to other markers because it needs specific primers. We designed and synthesized arbitrary primers and then ligate to the DNA fragment.
AFLP technology has the capability to detect the various polymorphism in different genomic regions. AFLP are highly reliable and reproducible and it is very sensitive methods which detect polymorphism in DNA. That's why AFLP techniques or method widely used for identifying the genetic variation between the related species they may be plant, fungi, bacteria, animals. Also helps in the study of taxa, paternity test and in solving the criminal cases. The first step in AFLP,
digestion of cellular DNA with the help of restriction enzyme which are rare cutter (EcoRI or PstI) and also by (Mse I and Taq I) restriction enzymes. Oligonucleotide adapters are ligated both the ends of fragments by which we obtain known sequence for PCR amplification. After then, visualize the banding pattern by gel electrophoresis or by on denaturing polyacrylamide gel with autoradiography, RAPD and AFLP do not require any information about DNA from organisms and both are dominant markers. DNA fragments obtained ranging from 60-500bp.

Figure 3: AFLP genotyping and fingerprinting

Sequence Characterized Amplified Region (SCAR)
RAPD derived molecular marker (1993) is SCAR marker which was first developed by Paran and Michel-More for downy Mildew resistance in Lettuce. They used SCAR marker as a genetic marker for tagging the gene of interest in Lettuce from parents of mapping population. SCAR is highly reproducible marker as well as fast and reliable from the other markers. In this the designed primers are used to identify the target species from the pool of related species by the presence of single, distinct and bright band in the desired sample. When RAPD combined with SCAR marker, the procedure becomes simple. PCR primers designed from the sequence of RAPD amplicons. SCAR marker has longer primer with specific sequence and high level of polymorphism. Other different markers like AFLP, SSR also been used to produce this marker. Other DNA based markers are being costly, time consuming that’s why SCAR marker have been used than those. It also has high detection sensitivity, avoidable electrophoresis. SCAR technology is best for authentication of traditional medicinal plants. SCAR marker is also helpful.
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in the detection of homogeneous and heterogeneous formulation. It is also used in medicinal system for authentication of herbal drug and sex identification of the plantlets.

Figure 4: SCAR marker

**Single Nucleotide Polymorphism (SNP)**

Single Nucleotide Polymorphism is a variation in single nucleotide which is mostly present at a specific position in the genome. Variation will be present at considerable rate within the population. SNP may exist within the coding sequence of genes, intergenic region or non coding region of the genes. Due to degeneracy of genetic code SNP do not necessarily changes the amino acid sequence of produced proteins. From this SNP divided into two types:

**Synonymous** (Do not affect protein sequence)

**Non-Synonymous** (Changing in the amino acid sequence of protein)

Non-Synonymous further divided into two types:-

1) **Missense**
2) **Non-sense**

SNP’s is not protein coding region may still affect gene splicing, messenger RNA degradation, transcription factor binding. SNP’s plays a great role in biomedical research in genome wide association studies. In which it relates gene mapping between normal or disease traits. SNP’s without any observable impact on phenotype are still useful as genetic marker in genome wide association studies, because of their quantity and the stable inheritance over generation. SNP’s helpful in disease diagnosis, drug discovery and development, drug responses and investigation of migration patterns. Many techniques like hybridization techniques (Microarray, Real time PCR), enzymes based techniques (nucleotide extension, cleavage, ligation, reaction product
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detection and display) to detect known polymorphism. SNP's markers are co-dominant and linked to genes. It is used in genetic study as well as in breeding. SNP must be present in at least 1% of individual in a population to qualify as polymorphic and having at least two alternative allelic forms at the locus concerned. SNP's arises mutation involving base pair substitution or form error in DNA duplication. SNP density can be predicted by the presence of microsatellites: AT microsatellites in particular are potent predictors of SNP density, with long (AT) repeats trending to be found in region of significantly reduced SNP density and low (GC) content (Varela and Amos 2010).

Figure 5: Techniques used in SNP marker\textsuperscript{[14]}

Inter - Simple Sequence Repeats (ISSR)
ISSR marker was independently used many researches. But now, ISSR are also called as random amplified microsatellites (RAMs). Using adaptor or designed primers containing repetitive sequence which is complimentary to the microsatellite region. DNA segments in genome will be PCR amplified which are helpful in the study of genetic variation termed known as "ISSR Markers". ISSR is multilocus and produce multiple DNA fragment in single reaction. ISSR marker is highly reliable and high reproducible as compared to RAPD, less costly and time comparing with AFLP. From all markers it is an ideal genetic marker for various studies.

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CLASSIFICATION OF VARIOUS ENERGY RESOURCES

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INTRODUCTION

Energy is one of the most essential needs for humans. The discovery of fire by man led to the possibility of burning wood for cooking and heating thereby using energy. Energy is obtained by fossil fuels, hydroelectric power and nuclear power. For several thousand years, human energy demands were met only by renewable energy sources.

Energy can be classified into several types based on the following criteria

1. Exhaustible and Inexhaustible energy
2. Commercial and Noncommercial energy
3. Renewable and Non-Renewable energy
4. Conventional and Non-conventional energy

EXHAUSTIBLE ENERGY SOURCE

Exhaustible energy is energy produced by sources that cannot be replaced once it is used. Examples are coal, natural gas and oil, which are produced by fossil fuels. Exhaustible energy pollutes the air and water. The byproducts of these types of energy are acid rain, greenhouse gases and air pollution. Acid rain kills vegetation and pollutes the water. Greenhouse gases change the climate, which melts the ice caps. Air pollution can cause many fatal diseases such as asthma and lung cancer.

INEXHAUSTIBLE ENERGY

Inexhaustible energy is clean energy and never runs out. This type of energy causes little damage to the atmosphere, water or plants. Wind, solar, hydroelectric and geothermal energy are all examples.
COMMERCIAL ENERGY SOURCES

(i) **Coal and Lignite:** It has been considered as the major source of energy in India. It can be easily converted into other forms of energy such as electricity, gas and oil. The total estimate resources of coal are now placed at 1,48,790 million tonnes, but the mineable reserves are estimated to be 60,000 million tonnes i.e. on 40% of the total coal reserves. Lignite is brown coal with lesser amount of energy than black coal. In 1950-51, production of coal and lignite in India was 32.3 million tonnes which increased to 413 million tonnes in 2004-05.

(ii) **Oil and Gas:** Demand for fossil fuels grew rapidly with the growth of the industrial sector and transport services. Crude oil production has constantly been increasing since the beginning of economic plans in India. After Independence, the Government of India felt the need for oil exploration on an extensive scale, and therefore, the Oil and Natural Gas Commission (ONGC) was set up in 1956, and Oil India Limited (OIL) was established in 1959. Total recoverable reserves of oil are estimated to be 550 million tonnes and those of gas are estimated to be 500 billion cubic tonnes. Production of crude oil is estimated about 34 million tonnes in 2005. Coal and other fossil fuels play the most important role in the generation of the thermal power.

(iii) **Hydroelectric power:** It plays an important role in the field of power development in any country. Our country has made considerable progress in the field of hydroelectricity power generation. Hydroelectric power has several advantages over thermal power like:

- **a)** It is the most economical source of power.
- **b)** There no environmental pollution problem.
- **c)** There is no waste disposal problem.
- **d)** Generation of hydel-power depends on renewable water resources, whereas the generation of thermal power depends on the use of non-renewal resources like coal and petroleum oil. The annual hydroelectric potential is estimated to be around 90,000 MW (Mega-watt). Out of this, so far about 18,000 mw has been developed. This mean that only 20% of the total potential has been utilized. So, there is a vast scope for harnessing hydro-potential in India.

(iv) **Atomic or Nuclear Power:** India has also developed nuclear power. Uranium and thorium are both sources of nuclear power generation. India’s uranium reserves have been estimated to be of the order of about 70,000 tonnes, which is equal to 120 billion tonnes of coal. Similarly, our thorium reserves of 3,60,000 tonnes would be equivalent to 600 billion tonnes of coal. Considering the availability of uranium and thorium, the government of India took steps in setting up nuclear power plants at Tarapur (Maharashtra) named Tarapur Atomic Power Station (TAPS, 1969) Kalpakkam (Tamil Nadu) during 1984-86, Narora (Uttar Pradesh) during 1989-91.
NON-COMMERCIAL ENERGY SOURCES:

(i) **Fuelwood:**
   It is required for cooking purpose. The total fuel wood consumption has been estimated at about 223 million tonnes in 2001-02.

(ii) **Agricultural wastes:**
   It is also used in houses for cooking purpose. Agriculture waste are also used as feed and fodder for animals, roofing materials in Katcha houses. It has been estimated that for fuel alone, the consumption of agricultural wastes was around 65 million tonnes in 2001.

(iii) **Animal dung:**
   Dried dung of animals is commonly used as fuel in our rural India, out of the total estimated production of 324 million tonnes of animal dung, nearly 73 million tonnes (22.5%) is burnt as fuel every year.

RENEWABLE RESOURCES

When talking about classification of resources, we will first see the renewable resources. Renewable resources are those resources that can be replenished or renewed naturally over time. Air, water, wind, solar energy etc. are all renewable resources. Renewable resources can be easily renewed by nature.

(i) **Solar energy**

Sun is a big source of energy. The energy that we get from the Sun is called solar energy. All the natural phenomenon like the flowing of wind, water cycle, photosynthesis etc. are possible only due to solar energy. Now a day, solar energy is being used to cook food with the help of solar cookers, heat water, light streets, pump water for irrigating fields etc.

(ii) **Hydro-Energy**

Water is important natural resources. All living organisms need water to live. Humans need water for many purposes such as drinking, cleaning, cooking and for growing crops. Water flowing into the river or water stored in a dam is sources of hydro energy. The Simple method to use hydro energy is to convert it into electrical energy.

(iii) **Wind energy**
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Winds are constantly being created in nature. The windmill is a source of electrical energy. These windmills are generally established only at places where most of the days in a year strong winds are experienced. The energy from this wind is used for grinding grain, pumping water and to produce electricity. In India, many windmills have been set up in different places such as Tamil Nadu, Maharashtra, Rajasthan, Kerala, West Bengal and Gujarat.

(iv) Biogas

Biogas is a type of fuel which is a mixture of gases such as methane, carbon dioxide, hydrogen etc. which is obtained by decomposition of animal and plant wastes like animal dung, with the help of micro-organisms in the presence of water. It is used as fuel in gas stove especially in rural areas.

(v) Wood

Wood is an ancient and traditional source of energy. It is mainly a mixture of many carbohydrate compounds. Wood is used to cook food. It leads to deforestation and pollutes air also. In India, still in many villages, they use wood chullas to cook food every day. While having ill effects on the environment, it is also harmful to human health.

(vi) Hydrogen

It is a good source of energy because it does not create pollution and produce maximum energy on burning. Hydrogen has the potential to be the answer to all our energy and fuel troubles. Technology is currently being developed to fully utilize hydrogen efficiency.

(vii) Alcohol

Alcohol has many commercial and medical purposes. It can use for producing energy. It can be obtained while making sugar from sugarcane. Thus it is a very cheap source of energy. A mixture of petrol and alcohol is being used as a fuel in automobiles. This mixture is called ‘Gasohol’.

(viii) Air

All living things need air to breathe. Therefore, air is an important natural resource.

(ix) Water

All living things need water in order to survive and the water cycle means we will essentially never run out of the water. But we must be careful not to pollute water and make it unusable. Drinking and clean water are already scarce in the world.
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(x) Soil

It is an important resource as this is the layer where plants grow. We all need food in order to survive. We get most of our food from crops grown in the soil.

NON RENEWABLE RESOURCES

The other classification of resources is non-renewable resources. Non-renewable resources are those natural resources that are available in limited quantity. These resources cannot be renewed or replenished in short duration. Therefore, they are also known as exhaustible resources. Examples—coal, natural gas, petroleum etc.

FOSSIL FUEL

Fossil fuels like coal and petroleum are non-renewable resources. They are found deep inside the earth and are made by natural processes over many centuries. Their quantity is limited and they take thousands of years to get renewed. Example of fossil fuels is coal, petroleum, natural gas etc.

- **Coal**: It is also known as black diamond. Coal is used as a fuel, to generate electricity, and in factories and steam engines.

- **Natural gas**: Natural gas is used as a fuel called Compressed Natural Gas or CNG. Some wells dug into the earth produce only natural gas. Natural gases are a good alternative to petrol and diesel and it is used as Compressed Natural Gas. It burns easily and produces a lot of heat. It is a good source of hydrogen.

- **Petroleum**: Petroleum is also known as mineral oil or crude oil. This liquid mineral is refined to make fuels such as petrol, diesel, cooking gas and kerosene. Plastic, cosmetics, and lubricants are also products of petroleum. It is found deep inside the Earth or under the sea floor. It is taken out by drilling wells deep into the Earth or under the seabed.

NUCLEAR ENERGY

In the classification of resources, nuclear energy is classified as non-renewable. The fuel used for nuclear energy is generally uranium, which is in a limited supply. So we classify it as non-renewable. Production of electricity from nuclear energy does not release carbon dioxide. Thus, use of nuclear energy is safe for the environment.
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CONVENTIONAL SOURCES OF ENERGY

Conventional sources of energy are the natural energy resources which are regularly used for many years and are accepted as fuel to produce heat, light, food and electricity. The energy sources include firewood, fossil fuels, cow dung cake etc. Of these sources, fossil fuel is the greatest conventional source, wherein fossil implies the remains of plants and animals that got buried under the earth and transformed into rocks over the years. These fossil fuels are coal, oil (petroleum), and natural gas.

Conventional sources of energy are generally non-renewable sources of energy as the accumulation or creation of conventional sources of energy takes years, once they are exploited or consumed. As these sources are used on a large scale, the reserves have been depleted, and their alternative is hard to find.
NON-CONVENTIONAL SOURCES OF ENERGY

An alternative to conventional sources of energy is the non-conventional sources of energy, that achieved popularity in recent years, after the oil crisis in 1973 and since then they are in use on a large scale. The energy can be obtained from various sources such as the sun, wind, biological wastes, hot springs, tides, etc. to generate heat and power.

Table 1: Sources of energy: conventional and non-conventional

<table>
<thead>
<tr>
<th>BASIS FOR COMPARISON</th>
<th>CONVENTIONAL SOURCES OF ENERGY</th>
<th>NON-CONVENTIONAL SOURCES OF ENERGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meaning</td>
<td>Conventional sources of energy are the sources that are commonly in use since long time.</td>
<td>Non-conventional sources of energy refers to the sources that are identified few decades ago.</td>
</tr>
<tr>
<td>Exhaustible</td>
<td>They can be exhausted due to over consumption.</td>
<td>They cannot be exhausted.</td>
</tr>
<tr>
<td>Pollution</td>
<td>They pollute environment, on a large scale and adds to global warming.</td>
<td>They are environment friendly sources, which does not causes pollution.</td>
</tr>
<tr>
<td>Use</td>
<td>They are primarily used for industrial and commercial purposes.</td>
<td>They are mainly used for domestic purposes.</td>
</tr>
<tr>
<td>Expense</td>
<td>Costly.</td>
<td>Comparatively less expensive.</td>
</tr>
</tbody>
</table>
Table 2: Currently available renewable energy technologies

<table>
<thead>
<tr>
<th>Options</th>
<th>Status</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small hydro</td>
<td>Virtually all are commercial</td>
<td>Factor Intermittent to base load</td>
</tr>
<tr>
<td>Horizontal and vertical axis wind turbines, Wind Pumps</td>
<td>Commercial, New designs under development.</td>
<td>Variable, 20 to 40%</td>
</tr>
<tr>
<td>Solar</td>
<td>Mostly commercial. Some under development or refinement</td>
<td>W/o storage: &lt;25%, intermittent W/thermal storage: 40 to 60%, intermediate</td>
</tr>
<tr>
<td>Geo-thermal</td>
<td>Commercial. Exploration and drilling improvements underway</td>
<td>High, base load.</td>
</tr>
<tr>
<td>Bio-energy</td>
<td>Many commercial, More under development or refinement.</td>
<td>US wood plants average 95+% Intermediate, peaking also possible.</td>
</tr>
</tbody>
</table>
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These are not only renewable sources of energy but are also pollution free. These sources are present in abundance in nature, and they are constantly generated, so it cannot be exhausted easily, and used again and again.

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INTRODUCTION

Soil is a natural body which made by weathering of native rocks as an important role for supporting of plants and provides nutrients and minerals. Soil erosion is a major problem in India it affects the environment, agronomic productivity, food security and farmers cultivation cost. Water is essential for human, animal and plant life. Water present in plant is 90-95 per cent. Water is also required for translocation of nutrients. The Water provides to soil moisture entire life of crop for growth and development. Once the most appropriate land use has been determined, soil conservation is a matter of good management of the land (Manyatsi, 1998).

In India, about 68.4% (82.57 million ha) of the total degraded lands (120.72 million ha) is degraded due to water erosion, followed by chemical degraded (24.68 million ha), wind erosion (12.40 million ha) and physical degradation (1.07 million ha) (Maji, 2007). As per an estimate by Central Soil & Water Conservation Research & Training Institute (CSWCRTI), Dehradun, about 5334 million tonnes (16.35 t ha\(^{-1}\)) of precious soil is lost annually, resulting into a loss of 5.37 to 8.4 million tones of nutrients, reduction in crop productivity by <5% to >50%, floods/droughts, reduction in reservoirs capacity (1% to 2% annually), and loss of biodiversity.

There are three major measures considered for soil and water conservation: agronomic measures, soil management strategies and mechanical methods.

1. Agronomic Measures

In agronomic measures utilization of vegetation play key role of in reducing erosion. Soil management by dense vegetation growth; improve its physical structure which leads to erosion control. Vegetation growth is usually less expensive and deal directly with reducing raindrop impact, increasing infiltration, reducing runoff volumes and decreasing water velocities which result in reduction in soil and water loss with any adverse effect on Environment. Agronomic measures include mulching, crop management and agro forestry. These measures use the effect of surface covers to reduce erosion by water and wind (Mukankomeje, 2010).
1.1 Mulching
Mulch is a layer of different type of material such as residues of crops, grasses, perennial shrubs, farmyard manure, compost, by products of agro-based industries, or inorganic materials and synthetic products. Mulch’s impact on the soil erosion by high intensity of the rainfall, decreasing the velocity of runoff, and hence reducing the amount of soil loss has been demonstrated. Mulching is a possible solution might be mulching with brought-in organic material. In general, mulching is likely to be a useful erosion control method in India as this method both reduces soil loss and enhances water holding capacity, soil productivity and crop yields by increasing soil organic matter. Hence, mulching should be integrated into the existing farming systems of all farmers. By utilization of organic waste material as mulch also help in controlling environment pollution.

1.2 Crop Management
Soil loss can also be reduced by appropriate crop management, which includes cover cropping, multiple cropping, and high density planting. Different crop management practices have various beneficial effects as erosion is reduced, the physical, chemical, and biological soil properties are improved, and crop production is increased.

Cover Crops
Broadly defined, a cover crop is any annual, biennial, or perennial plant grown as a monoculture (one crop type grown together) or polyculture (multiple crop types grown together), to improve any number of conditions associated with sustainable agriculture. Cover crops are fundamental, sustainable tools used to manage soil fertility, soil quality, water, weeds (unwanted plants that limit crop production potential), pests (unwanted animals, usually insects, that limit crop production potential), diseases, and diversity and wildlife, in agro ecosystems (Lu et al. 2000). Cover crops such as the legumes or the grasses are plants that grow rapidly and close detaching soil particles and this keeps soil loss to tolerable limits, so cover crops play an important role in soil conservation (Sethuraman, and Naidu, 2008).

Cover crops also positively influence physical soil properties such as the infiltration rate, moisture content, and bulk density (Ademola and Olujide, 2014). They increase the organic matter content, nitrogen (N) levels by the use of N$_2$-fixing legumes, the cation exchange capacity, and hence crop yields (Mukankomeje, 2010). Improved fallows of short periods with selected tree or herbaceous species remain important as the long fallow periods that were part of the traditional shifting cultivation system for encouraging soil regeneration are possible. Hence, improved fallows have high potential for soil conservation especially in farming systems without fertilizer input.

Intercropping
Intercropping systems including different kinds of annual crops planted in alternating rows also reduce soil erosion risk by providing better canopy cover than sole crops (Morgan, 1995).
Growing maize between the cassava ridges increases the soil coverage and hence reduces the impact of rain (Laal, 1990). Intercropping systems generally contribute to erosion control. The increased coverage of the soil surface and the enhanced stability of soil aggregate reduce the erosivity of the rain and the erodibility of the soil. As the productivity of soils cultivated with different crop species is also increased, this measure is likely to be adopted as a soil conservation technology.

**Planting**

**Pattern/Time** Planting pattern, plant density, and time of planting also play an important role in soil conservation. Crops planted at close spacing or at a certain time provide a higher canopy during periods with high rainfall intensities and hence protect the soil from erosion (Junge *et al.* 2008).

**Crop Rotation**

Crop rotation is the practice of growing a series of dissimilar types of crops in the same area in sequential seasons for various benefits such as to avoid the upsurge of pathogens and pests that frequently occurs when one species is continuously cropped. Crop rotation also seeks to balance the fertility demands of various crops to avoid excessive depletion of soil nutrients. A traditional component of crop rotation is the replenishment of nitrogen through the use of green manure in sequence with cereals and other crops. It is one component of polyculture. Crop rotation can also improve soil structure and fertility by alternating deep-rooted and shallow-rooted plants (permaculture. wikia.com/wiki/Crop_rotation).

1.3 **Agroforestry**

Agroforestry is a collective name for a land use system in which woody perennials are integrated with crops and/or animals on the same land management unit. Agroforestry is an integrated approach of using the interactive benefits from combining trees and shrubs with intercropping (Jatropha & Onions crops and livestock. It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy and sustainable land-use systems (Mukankomeje, 2010). These systems can be advantageous over conventional agricultural and forest production methods through increased productivity, economic benefits, social outcomes and the ecological goods and services.

In agroforestry systems, trees or shrubs are intentionally used within agricultural systems, or non-timber forest products are cultured in forest settings. Knowledge, careful selection of species and good management of trees and crops are needed to optimize the production and positive effects within the system and to minimize negative competitive effects.

**Alley cropping** is a form of rows of trees planted at wide spacing while growing annual crops in the alleyways. The potential benefits of this design include the provision of shade, retention of soil moisture; protect soil quality, diversification of crops in time and space (Schoeneberger, 2009). The woody perennials in these systems can produce fruit, fuel, wood, and fodder. The
reduction of soil erosion by alley cropping obviously depends on the spacing between the hedges and the species. 2 to 4-m spacing is adequate for erosion control depending on species.

2. Soil Management Strategies

2.1 Conservation Tillage

The origin of conservation tillage is attempted to reduce soil erosion. Conservation tillage has been defined as ‘any tillage sequence that reduces the loss of soil or water relative to plough-till’; often it is a form of non-inversion tillage that retains a protective layer of mulch, and is more specifically aimed at soil and water conservation (SWC). The key technique used for SWC are (1) residue mulch and (2) an increase in surface roughness can be achieved by chisel ploughing, strip tillage, ridge-furrow systems or tillage method that cause soil inversion (Kassam et al. 2009).

• Minimum Tillage:

Minimum tillage describes a practice where soil preparation is reduced to the minimum necessary for crop production and where 15% to 25% of residues remain on the soil surface (Morgan, 1995).

• No-Till:

No-till or zero-tillage is characterized by the elimination of all mechanical seed bed preparation except for the opening of a narrow strip or hole in the ground for seed placement. The surface of the soil is covered by crop residue mulch or killed sod (Lal, 1983).

• Ridge Tillage and Ridge Tying:

Ridge tillage is the practice of planting or seeding crops in rows on the top, along both sides or in the furrows between the ridges which are prepared at the beginning of every cropping season. Tied ridging or furrow diking includes the construction of additional cross-ties in the furrows between neighboring contour ridges (Lal, 1990). This consists of covering the whole surface with closely spaced ridges in two directions so that the ground is formed into a series of rectangular depressions. The rainfall is held in place where it falls until it infiltrates into the soil. There will be no runoff and therefore no overland flow erosion. If the soil becomes saturated and the depression fill up and then overflow, the ridges will break. If they fail, the sudden release of runoff is likely to cause more serious damage.

2.2 Contour Tillage

Contour tillage is the farming practice of ploughing across a slope following its elevation contour lines. The rows formed have the effect of slowing water runoff during rainstorms so that the soil is not washed away and allows the water to percolate into the soil. In contour plowing, the ruts made by the plough run perpendicular rather than parallel to slopes, generally resulting in furrows that curve around the land and are level (en.wikipedia.org/wiki/Contour_plowing).

This can reduce soil loss from sloping land up to 50% compared with cultivated up-and-down the slope land. The effectiveness of contour farming varies with the slope steepness. Protection against more extreme storms is improved by supplementing contour farming with strip-cropping.
2.3 Strip farming

Strip farming is a method of farming used when a slope is too steep or too long, or when other types of farming may not prevent soil erosion.

This is a method by which strips of row crops and closely growing crops, planted on the contour, are alternated. Erosion is largely limited to the row-crop strips and soil removed from these is trapped in the next strip down slope which is generally planted with a leguminous or grass crop. The grass strips are about 2-4m wide and the cropped area about 15-45m wide depending on the slope. The size of strip will be determined by the number of passes one would make - meaning that the size of strip will be a function of the machinery to be used. The slope will also limit the strip size e.g., sloppy lands requires a smaller strip width, yet a rather flat land will necessitate a wider strip. The following equation can be used to determine the width of strip:

\[ W = 51.2 - (2.1 \times S) \]

Where:

- \( W \) = strip width (m),
- \( S \) = slope (%).

For example; if the slope of an area is 8%, then the appropriate stripe width would be: \( 51.2 - (2.1 \times 8) = 35.3 \) m. This works for slopes of between 3 -18% (Manyatsi, 1998; Mukankomeje, 2010).

Strip farming helps to stop soil erosion by creating natural dams for water, helping to preserve the strength of the soil. Certain layers of plants will absorb minerals and water from the soil more effectively than others. Strip farming helps to prevent mass erosion by having the roots of crops hold onto the soil to prevent it from being washed away. The main disadvantage with strip cropping is the fragmentation of the land which limits the efficient use of machinery so it is not suitable for highly mechanized systems. Smallholding is better served with strip cropping.

3. Mechanical or Physical Methods

Mechanical or physical methods depend upon manipulating the surface topography, for example, by installing terraces to control the flow of water. Mechanical measures are largely ineffective on their own because they cannot prevent detachment of soil particles (Mukankomeje, 2010). Their main role is in supplementing agronomic measures, being used to control the flow of any excess water that arises. In general, mechanical measures are effective soil conservation technologies as they reduce soil loss. But as the installation and maintenance is usually labour-intensive. Mechanical methods, including bunds, terraces, waterways, and structures such as vegetative barriers or stone lines installed on farm also can break the force of winds or decrease the velocity of runoff to reduce soil erosion.

3.1 Terracing

In agriculture, a terrace is a leveled section of a hill cultivated area, designed as a method of soil conservation to slow or prevent the rapid surface runoff of irrigation water.

Arguments continue today about whether radical terracing, involving the physical movement of soil into contoured terraces, is best. Some argue that a more passive and slower option, vegetative contour bunds, is more effective and sustainable. Radical terraces tend to be fairly expensive to construct and are labour intensive. Installation of radical terraces can increase
the risks of landslides and the leaching of nutrients if these are not well constructed and maintained. Radical terraces are generally accepted as the ultimate intensity in physical management of soil runoff and water retention management. Radical terraces require deep and fertile soils to justify the amount of time required for construction. Crops may respond poorly for one or more growing seasons on sites where subsoil is excavated during construction.

Radical terraces are generally graded backwards or "reverse slope" so that rainfall flows back toward the foot. Rooting depth and available soil moisture is increased, and when properly constructed, there is no net loss in planting surface area. Once they are built, soil fertility must be restored with the use of manure, lime and phosphorus if yields are to double or triple after some years. Since the risers are almost vertical, only 20% of the land area cannot be cropped, although it can still produce forage. Terracing, especially radical terracing is generally not carried out as a large scale operation on public lands. More often, the work is done by small farmers, assisted technically and financially by the government or projects.

Incentives to farmers may be necessary to accelerate the development of terraces. The construction of the terraces can be divided over several years. In order to "create" 0.25 ha of cultivable land, the upland farmer may work one month per year over four years, during periods of low agricultural activity (Mukankomeje, 2010).

Permanent structures of these kinds are effective soil conservation technologies as excessive soil loss and silting up of the fields are reduced. However, high labour intensity, time consuming regular inspections, high consumption of scarce farmland, and the large amounts of construction material required are factors that stop farmers from installing or maintaining terraces.

3.2 Contour Bunds
Contour bunds made of earth or stones or terraces that consist of an excavated channel and a bank or ridge on the downhill side for cultivating crops are permanent erosion control technologies (Morgan 1995, and Lal, 1995). The first are installed across slopes of low gradients, the latter at right angles to the steepest slope in hilly areas. Contour bunds are earth banks, 1.5 to 2 m wide, thrown across the slope to act as a barrier to runoff, to form a water storage area on their upslope side and to break up a slope into segments shorter in length than is required to generate overland flow. They are suitable for slopes of 2 to 15% are often used as permanent buffers in a strip cropping system. The banks are spaced at 10 to 20m intervals and are normally hand constructed.

3.3 Infiltration Galleries
These trenches are mostly used in rocky and sloped areas where other measures cannot work. They reduce surface runoff.

3.4 Waterways
Waterways such as cut-off drainage are permanent structures that aim to collect and guide excess runoff to suitable disposal points. They are constructed along the slope, often covered with grass to prevent destruction, and primarily installed in areas with high rainfall rates. The purpose of
waterways in a conservation system is to convey runoff at non-erosive velocity to a suitable
disposal point. A waterway must therefore be carefully designed.

The most satisfactory location of a waterway is in a well vegetated natural drainage line
where the slopes, cross-sections, soil and vegetation have naturally developed to received and
carry the runoff - it therefore needs only to be protected against deterioration. If there is no
natural waterway, than an artificial waterway needs to be constructed. Artificial waterways are
normally protected by grass (*Paspalum* spp, kikuyu, African star grass) and so are referred to
grass waterways. Grass waterways are shallow and wide to obtain the maximum spread of water
over a wide cross-section. A certain area of land has to be withdrawn from production and
dedicated to the protection of the soil. Grassed waterways can be used in areas where there is
sufficient moisture available to sustain a good grass cover. Where moisture is not sufficient and
irrigation is not feasible, then the waterway may be paved with stone, masonry, concrete or some
other durable material. The cross-section of waterways depends on the slope, soil texture and the
area to be drained. Waterways should have a parabolic cross-section and be covered densely with
locally adapted grasses. The deepest cut should be between 0.5 and 1.0 m. Generally, grasses
which spread by rhizomes are the best types for the purposes. Once a waterway is in place, it
should always be crosses with raised implements; otherwise the vegetation will be destroyed. In
the case of implements which cannot be raised, crossing lanes should be provided. Before the
onset of the rains, the grass in the waterway must be cut, so that the flow of water can proceed
smoothly without causing eddies. Fertilizers should be applied regularly according to the
requirements of the grass stand (Manyatsi, 1998).

3.5 Gully Controls
Gullies usually develop because of an imbalance in runoff conditions, and are almost always due
to man's activities. Gully control is therefore often an effort to restore a balance which need not
have been destroyed in the first place.

In most cases, gullies can be prevented through good land husbandry - by maintaining
infiltration capacity, vegetative cover, soil structure, etc. - and by simple measures to avoid
concentration of excess runoff. These are also the measures which ensure good crop yields,
growth of forest vegetation and fodder production. The prevention of gully formation is not a
burden on the land user but a natural consequence of good land management. Early interventions
are far more economical than late ones. A small gully or rill can easily be repaired. But if the
situation is allowed to deteriorate, the same gully may develop into something beyond economic
recovery. In most cases, gully control is aimed at preventing further damage and loss of
productive land rather than at reclaiming gullied land for agricultural use.

An eroded rill, on deepening and widening, becomes a gully. A gully is sufficient deep that it
will not be obliterated by normal tillage operations, whereas a rill is of lesser depth and would be
smoothed by ordinary tillage. Although there is loss of land due to gully erosion, often the
eroded soil is relocated to the lower parts of the same catchment. Gully erosion is formed by
many factors i.e. rainfall, vegetation cover, lithology, land form, and land use. Controlling gully
erosion can be difficult.
This means that gully preventive or control measures must produce short-term benefits in terms of increased yield, more land available for cultivation, and reliable crop yields through improved soil-water use (Manyatsi, 1998).

The first step in controlling gully erosion is fencing of the gully head to protect it from grazing cattle and/or wild animals. Second, diversion ditches or waterways should be installed to divert the surface runoff away from the gully head. The waterways should be properly designed and laid out. The runoff should be properly disposed to avoid erosion. The land use and soil management in the watershed area feeding into the gully should be changed to soil enhancing practices, i.e. planting cover crops and trees. Stabilising the eroding faces and bed of gully is an important step. Establishing vegetation at the gully bed to provide more biomass is an important factor in decreasing the sediment-carrying capacity of the gully runoff. Engineering structures for gully erosion are however expensive to install and maintain. There are a wide range of engineering structures, i.e. diversion channels, gabions, and check dams (Mukankomeje, 2010).

**Stabilization Structures**

Stabilization structures play an important role in gully reclamation and gully erosion control. Small dams, usually 0.4 to 2.0 m in height, made from locally available materials such as earth, wooden planks, brushwood or loose rock, are build across gullies to trap sediments and thereby reduce channel depth and slope. These structures should be used in association with agronomic treatment of the surrounding land where grasses, trees and shrubs are planted. The dams have to be carefully designed.

**Concrete check dam**

Construction of a stone check dam begins by sloping back the tops of the banks. A trench is then dug across the floor of the gully and into the banks into which the large rocks are placed to form the toe of the structure. Rocks smaller than 100 mm in diameter should not be used because they will be quickly washed out. A dam made of large rocks will leave large voids in the structure through which water jets may flow, weakening the dam. To avoid these effects, the dam should be made with a graded rock structure. An effective composition is 25% of rocks between 100 and 140 mm diameter, 20% between 150 and 190 mm, 25% between 200 and 300 mm, and 30% between 310 and 450 mm. A second trench should be made to mark the downstream end of the apron and filled with heavy rocks. A 100 mm thick layer of litter, such as leaves and straws is laid on the floor of the apron and covered with a solid pavement of rock. A thick layer of litter is also placed on the upstream face of the dam (Mukankomeje, 2010).

**Stone Lining**

The first point to be considered in simple and easy measures of soil conservation is farming on the contour. Structures on the contour are simpler and cheaper than graded channel terraces as there is no need to set them out on a precise gradient. They should be more or less on the contour, but small errors are not as important as in the case of graded channel terraces. A general term for simple structures on the contour is "stop wash lines". The form of such line will depend on what materials are available. On stony ground, using the stones to build stone lines...
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serves the dual purpose of clearing them from the filled as well as building the stop wash line. Where stones are not available, lines can be formed by piling up crop residues, perhaps with a few shovels of soil, and progressively built up later by adding weeds from hand hoeing. Stone lines can be used effectively to control sheet erosion as well as erosion along minor cattle tracks (Mukankomeje, 2010). All measures which are discussed above have improved soil and water resources apart facilitate in improving environment.

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GENOMIC IMPRINTING: AN EPIGENETIC PHENOMENON

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ABSTRACT
Genomic imprinting results in monoallelic gene expression in a parent-of-origin–dependent manner. It is achieved by the differential epigenetic marking of parental alleles. Over the past decade, studies in the model systems Arabidopsis thaliana and maize (Zea mays) have shown a strong correlation between silent or active states with epigenetic marks so genomic imprinting is an epigenetic process such as DNA methylation and histone modifications. These epigenetic marks are established (“imprinted”) in the germline (sperm or egg cells) of the parents and are maintained through mitotic cell divisions in the somatic cells of an organism, but the nature of the primary imprint has not been clearly established for all imprinted genes. Phenotypes and expression patterns of imprinted genes have fuelled the perception that genomic imprinting is specific to the endosperm, a seed tissue that does not contribute to the next generation. However, several lines of evidence suggest a potential role for imprinting in the embryo, raising questions as to how imprints are erased and reset from one generation to the next. Imprinting regulation in flowering plants shows striking similarities, but also some important differences, compared with the mechanisms of imprinting described in mammals. For example, some imprinted genes are involved in seed growth and viability in plants, which is similar in mammals, where imprinted gene regulation is essential for embryonic development. However, it seems to be more flexible in plants, as imprinting requirements can be bypassed to allow the development of clonal offspring in apomicts.

Keywords: Genomic Imprinting, Epigenetic, Phenotypes, Embryonic Development

THEORIES ON THE ORIGINS OF IMPRINTING
A widely accepted hypothesis for the evolution of genomic imprinting is the “parental conflict hypothesis” (Moore et al., 1991). Also known as the kinship theory of genomic imprinting, this hypothesis states that the inequality between parental genomes due to imprinting is a result of the differing interests of each parent in terms of the evolutionary fitness of their genes. The father's genes that encode for imprinting gain greater fitness through the success of the offspring, at the expense of the mother. The mother’s evolutionary imperative is often to conserve resources for her own survival while providing sufficient nourishment to current and subsequent litters. Accordingly, paternally expressed genes tend to be growth promoting whereas maternally expressed genes tend to be growth limiting.

IMPRINTED GENES IN PLANTS
A similar imprinting phenomenon has also been described in flowering plants (angiosperms). During fertilization of the egg cell, a second, separate fertilization event gives rise to the endosperm, an extra embryonic structure that nourishes the embryo in a manner analogous to the mammalian placenta. Unlike the embryo, the endosperm is often formed from the fusion of two
maternal cells with a male gamete. This results in a triploid genome. The uneven ratio of maternal to paternal genomes appears to be critical for seed development. Some genes are found to be expressed from both maternal genomes while others are expressed exclusively from the lone paternal copy (Nowack et al. 2007)

FUNCTIONS OF IMPRINTED GENES
The control of expression of specific genes by genomic imprinting is unique to the mammals (placental mammals and marsupials) and flowering plants. Imprinting of whole chromosomes has been reported in mealy bugs (Nur, 1990). It has also been established that X- chromosome inactivation occurs in an imprinted manner in the extra-embryonic tissues of mice and all tissues in marsupials, where it is always the paternal X- chromosome which is silenced. The majority of imprinted genes in mammals have been found to have roles in the control of embryonic growth and development, including development of the placenta. Other imprinted genes are involved in postnatal development, with roles affecting suckling and metabolism (Tycko et al. 2002)

IMPRINTING MECHANISMS
On double fertilization, two sperm cells are released from the pollen tube into the embryo sac, with one of them fertilizing the egg cell and the other one fertilizing the homo diploid central cell, resulting in the formation of a diploid embryo and a triploid endosperm, respectively. The endosperm is a functional analog of the mammalian placenta and serves to support and nurture the growing embryo (Berger, 2003). Imprinting in plants has long been believed to be restricted to the ephemeral endosperm that is not transmitted to the next generation. However, based on recent results showing that the maize imprinted gene maternally expressed in embryo 1 (mee1) is as well imprinted in the endosperm and during early embryo development this dogma has to be revised (Jahnke and Scholten, 2009). Thus, similar to mammals imprinting in plants is not restricted to ephemeral tissues but extends to tissues contributing to the next generation, suggesting that plants as well as mammals had to develop strategies that allowed the resetting of epigenetic marks in gametic cells to restore totipotency (Jahnke and Scholten, 2009). However, as there are no data yet available on the mechanism leading to establishment and resetting of imprinting marks in plant embryos, the emphasis of this review will be on novel findings illuminating mechanisms of imprinting establishment in the endosperm. Parent-of-origin-specific expression of genetically identical alleles is achieved by the application of specific epigenetic modifications in the gametes. In particular, DNA methylation and Polycomb group (PcG) mediated trimethylation of histone H3 at lysine 27 (H3K27me3) have been widely recognized as important epigenetic marks distinguishing maternally and paternally inherited alleles in mammals.

CONCLUSIONS AND PERSPECTIVES
Genomic imprinting has a major impact on seed development, both by influencing seed growth and viability. The developmental phenotypes of mutants affecting certain imprinted genes in plants are consistent with predictions made by the parental conflict theory, but other theories might also explain the evolution of genomic imprinting, which may have arisen due to distinct
selective pressures at different loci. Either alone or in combination, both DNA methylation as well as histone modifications is involved in imprinting regulation. Importantly, DNA methylation is not sufficient to establish imprinted gene expression at all loci described to date. For instance, it is not clear how paternal expression of HDG3 is achieved, as it is maternally hypomethylated in the endosperm (Gehring et al. 2009). Similarly, DNA methylation does not always correspond to the expression state at imprinted loci in maize, and alleles that show differential methylation in the fertilization products but not in the gametes must carry yet unknown primary epigenetic marks. The distinction of primary from secondary marks will be a focus of future research. Furthermore, the complexities of imprinting regulation clearly indicate the existence of additional, yet unknown, factors required for imprinted expression. For instance, the potential involvement of non-coding RNAs, which play an important role in imprinting regulation in mammals (Koerner and Barlow, 2010), has not been rigorously investigated. Unlike in the endosperm, where erasure and resetting mechanisms for imprints are not required because it does not contribute to the next generation, such mechanisms must exist for genes with imprinted expression in the plant embryo. Resetting mechanisms ensure that the epigenetic state of the parental alleles is not inherited from one generation to the next. Although maternal Mee1 alleles get remethylated during embryogenesis such that both alleles are equally methylated (Jahnke and Scholten 2009), this does not constitute such a resetting mechanism because it does not lead to a gender-specific distinction of the alleles. Because plants do not have a segregated germ line, the setting of a gender-specific primary imprint can occur only after the lineages for male and female reproductive organs have been separated. The fact that genomic imprinting in plants is rather versatile and the requirement for a paternal and maternal genome can be bypassed under certain circumstances is important. One fascinating aspect of plant reproduction is the ability of some species to propagate asexually through seeds. Maybe relaxed imprinting requirements were an essential preadaptation for the evolution of apomixis in these taxa. Therefore, apomixis research might benefit from an improved understanding of imprinting regulation and its function in seed development. New technologies allowing the molecular investigation of gametes and improved genome- wide approaches will uncover more imprinted genes and will certainly produce more detailed genome-wide epigenetic maps that add to our understanding of the role and the regulation of genomic imprinting in flowering plants.

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TRANSGENIC PLANTS AND ITS APPLICATIONS

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ABSTRACT
Before the creation of transgenics, the alteration of crops to improve their production was performed through the basis of selection. This selection has been going on for thousands of years. By the year 2050, world population may reach nine billions. Food production will need to increase at the high rate in order to satisfy the needs of such an enormous number of people in some older centuries. So, there is a need to use the genetic techniques to improve crops over the recent decades. Through the use of transgenics, one can produce plants with desired traits and even increased yields. The transgenics would allow for more crops that last longer and offers opportunities for the creation of insect, virus and herbicide-resistant plants by insertion and expression in planta of various genes. Abiotic stresses, especially salinity and drought, are the primary causes of crop loss worldwide. Transgenes protect and maintain the function and structure of cellular components and enhance tolerance to stress and also help in reducing micronutrient malnutrition among people at highest globally by enriching major staple food crops with micronutrients like amino acid, lipid, vitamin and iron through genetic engineering techniques. Transgenic plant production will allow us to feed the growing population and to produce more desirable products like secondary metabolites as antibodies and also help in preparation of edible vaccines. Genetic engineering also allows delayed ripening in fruits and helps to reduce fruit wastage. Molecular farming allows cost effective production of therapeutic products such as antibodies, blood products, cytokines, growth factors, hormones, recombinant enzymes and human and veterinary vaccines. The future of GM crops remains a vital debate, as its applications have several advantages and disadvantages.
Keywords: Transgenics, Genetic engineering, Resistance

INTRODUCTION
Transgenic plants also known as genetically modified crops (GMCs, GM crops or biotech crops) are those plants, which carry additional, stably integrated and expressed, foreign gene from trans species. These are the plants used in agriculture, the DNA of which has been modified using genetic engineering techniques. The aim is to introduce a new trait to the plant which does not occur naturally in the species. A transgenic plant contains a gene or genes that have been artificially inserted. The inserted gene sequence is known as the transgene, it may come from an unrelated plant or from a completely different species. The purpose of inserting a combination of genes in a plant, is to make it as useful and productive as possible. This process provides advantages like improving shelf life, higher yield, improved quality, pest resistance, tolerant to heat, cold and drought resistance, against a variety of biotic and abiotic stresses (Rani et al., 2013). Transgenic plants can also be produced in such a way that they express foreign proteins.
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with industrial and pharmaceutical value. Plants made up of vaccines or antibodies (Plantibodies) are especially striking as plants are free of human diseases, thus reducing screening costs for viruses and bacterial toxins. The first transgenic plants were reported in 1983. Since then, many recombinant proteins have been expressed in several important agronomic species of plants including tobacco, corn, tomato, potato, banana, alfalfa and canola.

The whole process of transgenic plants development involve

- Introduction
- Integration
- Expression of foreign gene in the host.

And is called genetic transformation.

The combined use of recombinant DNA technology, gene transfer methods and tissue culture techniques has led to efficient transformation and production of transgenics in wide variety of crop plants. Unlike conventional breeding, only the cloned gene of agronomic importance is being introduced without cotransfer of other undesirable genes from the donor. The recipient genotype is least disturbed and there is no need of repeated back crosses. This will serve as an efficient means of removing certain specific defects of otherwise well adopted cultivars.

TRANSGENIC PLANTS: APPLICATIONS

A. DEVELOPMENT OF INSECT, VIRUS AND HERBICIDE RESISTANT PLANT

Insecticidal resistance

Plant genetic engineering offers opportunities for the creation of insect-resistant plants by insertion and expression in planta of entomopathogenic proteins (Alstad et al., 1995). Two main approaches to obtain such plants have been explored. One approach involves a gene for an insecticidal protoxin by the bacterium Bacillus thuringiensis. Bacillus thuringiensis, during sporulation forms intracellular crystalline bodies that contain an insecticidal protein called the δ endotoxin (Aronson et al., 2002). The δ endotoxin (cry I, cry II, cry III) accumulates in the bacterium as an inactive precursor. After ingestion by the insect, the protoxin is cleaved by proteases, resulting in shorter versions of the protein that display the toxic activity, by binding to the inside of insect’s gut and damaging the surface epithelium. The second approach uses plant-derived genes, such as those encoding enzyme inhibitors or lectins (Jouanin et al., 1998). Through genetic engineering it is possible to develop crops that are resistant to insect.
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Fig1: Damage of insect midgut due to insecticidal protein

<table>
<thead>
<tr>
<th>Gene</th>
<th>Bacterial strain</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>cryIA</td>
<td>HD-1</td>
<td>Lepidoptera</td>
</tr>
<tr>
<td>cryIIA</td>
<td>HD-263</td>
<td>Lepidoptera &amp; Diptera</td>
</tr>
<tr>
<td>cryIII B</td>
<td>Tolworthi</td>
<td>Coleopteran</td>
</tr>
<tr>
<td>cryIVA</td>
<td>Israeliensis</td>
<td>Diptera</td>
</tr>
<tr>
<td>cryV</td>
<td>-</td>
<td>Nematodes</td>
</tr>
</tbody>
</table>

Table1: The cry genes of B. thuringiensis and target insects
**Virus Resistance plants**

The theory of pathogen-derived resistance (PDR) proposes that pathogen resistance genes can be derived from a pathogen's own genetic material (Sanford and Johnston, 1985). Numerous examples of PDR have been reported for many different plant RNA viruses in a wide range of plant species. Most examples of PDR involve transgenic plants engineered to express a viral coat protein (CP) or a segment of a replicase gene. Several approaches have been used for virus resistance, such as induction of coat protein gene, antisense RNA approach, and ribozyme mediated protection (Lindbo et al.,1993). The use of coat protein has been most successful. Transgenic plants having a virus coat protein gene linked to strong promoter have been produced in many crop plants as tobacco, tomato, alfalfa, potato etc. The first transgenic plant of this type was tobacco produced in 1986. It contained the coat protein gene of Tobacco Mosaic Virus. When these plants were inoculated with TMV, symptoms either failed to develop or were considerably delayed. The effectiveness of coat protein (CP) gene in conferring resistance can be affected by both the amount of coat protein produced in transgenic plants and by the concentration of virus inoculums. The resistance generated by the CP is due to the blocking of the process of uncoiling of virus particles, which is necessary for the viral genome replication as well as expression. In other approach, the transgenic expression of dysfunctional viral movement proteins (MP) is used to make the plant resistant. The protection conferred by mutant MP of TMV e.g. mediates resistance to other virus also.

**Table 2: Virus resistant transgenic plants with sources of virus protein coat genes**

<table>
<thead>
<tr>
<th>Plant</th>
<th>Source of virus coat protein gene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco</td>
<td>TMC, CMV, AIMV</td>
</tr>
<tr>
<td>Rice</td>
<td>RTSV, RSV, RYMV</td>
</tr>
<tr>
<td>Wheat</td>
<td>SBWMV, BYDV</td>
</tr>
<tr>
<td>Potato</td>
<td>PVX, PVY, PLRV</td>
</tr>
<tr>
<td>Squash</td>
<td>CMV, ZYMV</td>
</tr>
<tr>
<td>Sugarbeet</td>
<td>BNYVV</td>
</tr>
<tr>
<td>Peanut</td>
<td>ISWV</td>
</tr>
<tr>
<td>Papaya</td>
<td>PRSV</td>
</tr>
<tr>
<td>Citrus</td>
<td>CTV</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>AIMV</td>
</tr>
</tbody>
</table>
Herbicidal resistance

Phosphinothricin (PPT) is a potent inhibitor of glutamine synthetase in plants and is used as a non-selective herbicide. The bar gene which confers resistance in *Streptomyces hygroscopicus* to bialaphos, a tripeptide containing PPT, encodes a phosphinothricin acetyltransferase (PAT) (De Block *et al.*, 1987). The bar gene was placed under control of the 35S promoter of the cauliflower mosaic virus and transferred to plant cells using *Agrobacterium*-mediated transformation. PAT was used as a selectable marker in protoplast co-cultivation. The chimeric bar gene was expressed in tobacco, potato and tomato plants. Transgenic plants showed complete resistance towards high doses of the commercial formulations of phosphinothricin and bialaphos. These present a successful approach to obtain herbicide-resistant plants by detoxification of the herbicide. Many crops have been engineered for resistance to herbicides such as glyphosate. Glyphosate is a non-selective herbicide that inhibits 5-enol-pyruvylshikimate-3-phosphate (ESPS) synthase, a key enzyme in the biosynthesis of aromatic amino acids in plants. ESPS synthase converts shikimate and phosphoenolpyruvate into 5-enol-pyruvylshikimate-3-phosphate, a precursor for synthesis of aromatic amino acids tryptophan, tyrosine and phenylalanine. Glyphosate competes with phosphoenolpyruvate for binding with ESPS synthase (Steinrücken *et al.*, 1984). Two approaches have been used to engineer resistance so that herbicide can be used for weed control without damaging the crop.

- In the first approach, the target protein of the herbicide (EPSP synthase) can be overproduced so that resistance occurs as a consequence of having more enzyme available to cell.
- A second approach results from expression of a mutant version of EPSP synthase that is resistant to the herbicide within the cells

<table>
<thead>
<tr>
<th>Genes for herbicide resistance</th>
<th>Source organism</th>
<th>Confers resistance to the herbicide</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>aroA</em></td>
<td><em>Agrobacterium</em> sp. Stain CP4</td>
<td>Glyphosate</td>
</tr>
<tr>
<td><em>Bar</em></td>
<td><em>Streptomyces hygroscopicus</em></td>
<td>Glufosinate</td>
</tr>
<tr>
<td><em>Bxn</em></td>
<td><em>Klebsiella ozaene</em></td>
<td>Bromoxynil</td>
</tr>
</tbody>
</table>
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Fig 2: Transgenic plant showing herbicidal resistance

B. DEVELOPMENT OF STRESS TOLERANT PLANT LIKE OXIDATIVE STRESS AND SALT STRESS

Abiotic stresses, especially salinity and drought, are serious threats to the sustainability of crop yields accounting for more crop productivity losses than any other factor in rainfed agriculture. Plant adaptation to environmental stresses is dependent upon the activation of cascades of molecular networks involved in stress perception, signal transduction, and the expression of specific stress-related genes and metabolites (Bhatnagar-Mathur et al., 2008). Success in breeding for better adapted varieties to abiotic stresses depend upon the concerted efforts by various research domains including plant and cell physiology, molecular biology, genetics, and breeding. Use of modern molecular biology tools for elucidating the control mechanisms of abiotic stress tolerance, and for engineering stress tolerant crops is based on the expression of specific stress-related genes (Vinocur et al., 2005). Hence, genetic engineering for developing stress tolerant plants, based on the introgression of genes that are known to be involved in stress response and putative tolerance, might prove to be a faster track towards improving crop varieties. Far beyond the initial attempts to insert “single-action” genes, engineering of the regulatory machinery involving transcription factors has emerged as a new tool now for controlling the expression of many stress-responsive genes. Nevertheless, the task of generating transgenic cultivars is not only limited to the success in the transformation process, but also proper incorporation of the stress tolerance.
### Table 4: Transgenes conferring resistance to several abiotic stresses

<table>
<thead>
<tr>
<th>Transgene</th>
<th>Isolated from</th>
<th>Transferred into</th>
<th>Protection from abiotic stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>mtl1D</td>
<td><em>E.coli</em></td>
<td>Tobacco</td>
<td>Salt stress</td>
</tr>
<tr>
<td>P5CS</td>
<td>Mothbean</td>
<td>Tobacco</td>
<td>Salt stress</td>
</tr>
<tr>
<td><em>Hsf</em></td>
<td>Heat shock factor</td>
<td>Tobacco</td>
<td>Heat stress</td>
</tr>
<tr>
<td><em>sacB</em></td>
<td><em>Bacillus subtilis</em></td>
<td>Tobacco</td>
<td>Drought</td>
</tr>
<tr>
<td>hva1</td>
<td>Barley</td>
<td>Rice</td>
<td>Salt stress</td>
</tr>
<tr>
<td><em>ACC synthase</em></td>
<td>Carnation</td>
<td>Tobacco</td>
<td>Several abiotic stresses</td>
</tr>
</tbody>
</table>

### C. MODIFICATION OF PLANT NUTRITIONAL CONTENT LIKE AMINO ACID, LIPID, VITAMIN AND IRON

This global crisis in nutritional health is the result of dysfunctional food systems that do not consistently supply enough of these essential nutrients to meet the nutritional requirements of high-risk groups (Welch 2005). One sustainable agricultural approach to reducing micronutrient malnutrition among people at highest risk (i.e. resourcepoor women, infants and children) globally is to enrich major staple food crops with micronutrients like amino acid, lipid, vitamin and iron through genetic engineering techniques (Šramková et al., 2009).

The use of genetic engineering techniques allows scientists to develop the plants with improved nutritional quality e.g. rice is extremely low in vitamin A. Potrykus and Beyer developed genetically engineered rice (known as golden rice) which is enriched in provitamin A by introducing 3 genes involved in biosynthetic pathway for carotenoids, the precursor for vitamin A. To obtain a functional provitamin A (β- carotene) biosynthetic pathway in rice endosperm, genes coding for phytene synthase (*pys*) and lycopene cyclase (*lyc*) both from *Narcissus pseudonarcissus* together with a gene coding phytene desaturase (*crt I*) from bacteria (*Erwinia uredovora*) were introduced.
Table 5: Development of Golden Rice

<table>
<thead>
<tr>
<th>Enzyme activity of Golden Rice</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytoene synthase (a plant gene)</td>
<td>Produces phytoene by condensation of 2 molecules of geranyl geranyl pyrophosphate</td>
</tr>
<tr>
<td>Phytoene desaturase</td>
<td>Converts phytoene into zeta-carotene</td>
</tr>
<tr>
<td>z- carotene desaturase</td>
<td>Converts zeta-carotene into lycopene</td>
</tr>
<tr>
<td>Lycopene -β- cyclase</td>
<td>Converts lycopene into β-carotene, the cyclic C40 carotene, which is commonly known as provitamin-A</td>
</tr>
</tbody>
</table>

D. PLANTS AS BIOREACTOR FOR PRODUCTION OF ANTIBODIES, POLYMERS ETC.

Plant secondary metabolites known to play a major role in the adaptation of plants to their environment, but also represent an important source of active pharmaceuticals. Plant cell culture technologies were introduced at the end of the 1960s as a possible tool for both studying and producing plant secondary metabolites (Bourgaud et al., 2001). Different strategies, using in vitro systems, have been extensively studied with the objective of improving the production of secondary plant compounds as antibodies, polymers etc. Plants have been used for production of monoclonal antibodies (plantibodies); the polymer polyhydroxybutyrate, which is used to make a biodegradable plastic like material, and a number of potential therapeutic agents like, human protein C (anticoagulant), human hirudin variant 2 (anticoagulant), human erythropoietin (anemia), human alpha interferon (hepatitis C and B) and human growth hormone (dwarfism). The term plantibodies is used for antibodies that are synthesized in transgenic plants. The difference between plantibodies and edible vaccines is that plantibodies are pre-made antibodies that are produced in the transgenic plant; whereas edible vaccines promote the production of specific antibodies by human immune system. Plantibodies are advantageous for people who are immunosuppressed and are unable to produce antibodies even after they are vaccinated.

E. SYNTHESIS OF EDIBLE VACCINES

The use of plants for medicinal purposes dates back thousands of years but genetic engineering of plants to produce desired biopharmaceuticals is much more recent. As the demand for biopharmaceuticals is expected to increase, it would be wise to ensure that they will be available in significantly larger amounts, on a cost-effective basis. Currently, the cost of biopharmaceuticals limits their availability. Plant-derived biopharmaceuticals are cheap to produce and store, easy to scale up for mass production, and safer than those derived from animals (Daniell et al., 2001).
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Commercial vaccines are expensive to produce and package, and require trained personnel to administer injections. So vaccines are available in edible form e.g. as a part of fruit or vegetable. An edible vaccine wouldn’t require elaborate production facilities, purification, sterilization, packaging or specialized delivery system. The gene encoding of the orally active antigenic protein is isolated from the pathogen, and a suitable construct for constitutive or tissue-specific expression of gene is prepared. The gene is introduced and stably integrated into the genome of selected plant species and expressed to produce the antigen. The appropriate plant parts containing the antigen may be fed raw to humans to bring about immunization.

**Fig3: Synthesis of edible vaccine using potato leaves**

**F. DELAYED RIPENING**

Genetic engineering is used to delay ripening in fruits. One of the genes, encoding the polygalacturonase, is involved in slow breakdown of the polygalacturonic acid component of cell walls in the fruit pericarp (Sheehu et al., 1988). Its effects result in gradual softening that makes the fruit edible. However, if the effects of enzymes can be delayed, then the fruit will ripen more slowly. Tomatoes have been engineered so that they express less of polygalacturonase enzyme using antisense technology. Using antisense technology, Calgene Fresh Inc. (USA) has permanently introduced an antisense copy of gene for polygalacturonase with aid of *Agrobacterium tumefaceins*. The presence of complementary sense and antisense RNA molecules in the same cell can lead to the formation of stable duplex, which may interfere RNA processing or possibly translation. This prevents the tomato from making the usual amount of polygalacturonase. This genetically modified tomato –marketed under the trade name *Flavr Savr* which resist softening and have extended self-life.
G. PRODUCTION OF BIOPLASTICS

The bacteria *eutrophus* produce polyhydroxybutyrate (PHB), a biodegradable and renewable biopolymer (Holmes *et al.*, 1985). The gene from *A. eutrophus* that codes for an enzyme responsible for biosynthesis of PHB is being transferred to plants for production of biodegradable plastics.
H. MOLECULAR FARMING

Plants provide an inexpensive and convenient system for the large-scale production of valuable recombinant proteins (Hoja et al., 2001). This principle has been demonstrated by the commercial success of several first-generation products, and many others are currently under development. Over the past ten years, several efficient plant-based expression systems have emerged, and >100 recombinant proteins have now been produced in a range of different species (Twyman et al., 2003). It is an application of genetic engineering in which genes, primarily of human and animal origin are introduced into plants or farm animals for cost effective production of therapeutic products such as antibodies, blood products, cytokines, growth factors, hormones, recombinant enzymes and human and veterinary vaccines. Therapeutic compounds so produced are also known as biopharmaceuticals. The organisms in which gene coding for the target therapeutically active compound introduced are often referred to as expression system. It includes bacteria, yeast, plant viruses, animal cell culture, transgenic plants and transgenic animals. The first recombinant pharmaceutical protein produced in plant was human serum albumin, first produced in 1990 in transgenic tobacco and potato plants. Some examples:

Table 6: Different proteins derived from different plant cultures

<table>
<thead>
<tr>
<th>Plant Source</th>
<th>Protein Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco, sunflower(plants)</td>
<td>Growth hormone</td>
</tr>
<tr>
<td>Tobacco, potato(plants)</td>
<td>Serum, albumin</td>
</tr>
<tr>
<td>Tobacco (plants)</td>
<td>Epidermal growth factor</td>
</tr>
<tr>
<td>Rice (plants)</td>
<td>Alpha-interferon</td>
</tr>
<tr>
<td>Tobacco (cell culture)</td>
<td>Erythropoietin</td>
</tr>
<tr>
<td>Tobacco (plants)</td>
<td>Haemoglobin</td>
</tr>
<tr>
<td>Tobacco (cell culture)</td>
<td>Interleukins-2 and 4</td>
</tr>
<tr>
<td>Tobacco (root culture)</td>
<td>Placental alkaline phosphatase</td>
</tr>
</tbody>
</table>
ADVANTAGES OF TRANSGENIC PLANTS

- Improvement in yield.
- Improvement in insect and disease resistance.
- Improvement in quality.
- Herbicide resistance.
- Resistance to Abiotic Stresses.
- Industrial products.
- Longer shelf life.
- Rapid and accurate technique.
- No barrier of gene transfer.
- Use of very less chemicals, thus little impact to environment.

DISADVANTAGES OF TRANSGENIC PLANTS

- Allergic reactions.
- Production of toxins.
- Reduced nutrition value.
- Release of toxins to soil.
- Resistance of pest to toxins.
- Disruption to biodiversity
CONCLUSION

Now a days, agricultural biotechnology may be viewed as a complement to conventional agriculture. It is a scientific tool that can aid plant breeding programs and the conservation of genetic resources, as well as improve the treatment of plant diseases. Transgenic plants have the potential to solve many of the world’s hunger and malnutrition problems, and to protect the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides. As we know Science cannot declare any technology risk free. Although genetically engineered crops can reduce some environmental risks associated with conventional agriculture, but will also introduce new challenges that must be addressed.

REFERENCES


INNOVATIVE APPROACH IN AGRICULTURE FARMING

ANTIOXIDANT AND PHYTOCHEMICAL ANALYSIS OF TINOSPORA CORDIFOLIA AND OCIMUM SANCTUM

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2Associate Professor, Department of Botany, Meerut College Meerut
Email: sumitbotmcm@gmail.com

ABSTRACT
Over the centuries, plants have been one of the important sources of many traditional medicines throughout the world. A number of medicinal plants, traditionally used for thousands of years are present in a group of herbal preparations of the Indian traditional health care system which possess interesting antioxidant activities. In India, approximately 3000 plant species have been reported to have medicinal properties. Antioxidants derived from medicinal plants used in the prevention and treatment of oxidative stress related diseases. They may protect cells from damage caused by unstable molecules known as “free radicals”. They terminate chain reactions by removing free radical intermediates and inhibit the oxidation reactions by being oxidized themselves. In the present study methanol extract of Tinospora cordifolia and Ocimum sanctum leaves extract were screened for the presence of phytochemical compounds and tested for antioxidant activity by DPPH (2,2-diphenyl-1-picrylhydrazyl) assays. Result revealed the presence of alkaloids, steroids, tannins, and flavonoids. Antioxidant activity of extract of leaves of Tinospora cordifolia and Ocimum sanctum would lead to the establishment of some compound that show relation to diet, drugs, food preservatives and industrial uses.

Keywords: Phytochemical screening, Tinospora cordifolia, Ocimum sanctum, leaves extract, antioxidant activity DPPH assays.

INTRODUCTION
Synthetic antioxidants like butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA) commonly used in processed foods have side effects and are carcinogenic (Fukushima et al.,1983). Presently, the use of natural antioxidants present in fruits, vegetables and in other parts of plants has attracted considerable interest due to their nutritional and therapeutic value. They may protect cells from damage caused by unstable molecules known as free radicals (Velavan et al.,2007). Free radicals are atoms or groups of atom with an odd (unpaired) number of electrons and can be formed when oxygen interacts with certain molecules. Antioxidants terminate these chain reactions by removing free radical intermediate and inhibit other oxidation reactions by being oxidized themselves. To prevent free radical damage, the body has a defense system of antioxidants which include extracellular and intracellular antioxidants. Enzymes like superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPO), glutathione reductase are

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intracellular antioxidants within biological system, a number of small molecular weight antioxidants are capable of acting as repair or sacrificial antioxidants because they are chain breaking antioxidants e.g. uric acid, bilirubin, transferring, albumin, heptaglobin, tocopherol, ascorbic acid, glucose etc. initiation starts with the abstraction of a hydrogen atom from the biomolecules for e.g. fatty acid (LH) can be converted into radicals (L). The hydroxyl (OH), alkperoxyl (ROO⁻) and alkoxyl (RO⁻) radicals are capable of oxidizing PUFAs. Extremely rapid addition of oxygen to the fatty acid radicals then generate peroxy radicals (LOO⁻) that propagate the reaction by initiating a new chain of oxidation with the formation lipid hydro peroxide (LOOH). This chain reactions continues till an antioxidant interrupts it through scavenging the radicals, the termination step (Schafer et al.). Because of the immense reactivity of free-radicals, they can easily react with several bio-molecules including DNA, lipids, proteins and carbohydrates. Free- radicals react with bio-molecules, leading to local injury and eventual organ dysfunction. They also accelerate the aging and related degenerative process. Moreover, free radicals are also involved in the promotion of heart diseases, chronic inflammation and cancers (Ivanovo and Ivanov, 2000). Thus, the aim of present investigation is to phyto-chemically screen for antioxidant potential of some Indian medicinal plants growing in and around C.C.S. University Campus Meerut.

OBJECTIVE

1. Phytochemical screening of stem and leaves (extract in chloroform and methanol) of 
   *Ocimum sanctum* and *Tinospora cordifolia* for-
   a. Alkaloids
   b. Steroids
   c. Tannins and
   d. Flavonoids, and
2. Determination of antioxidant activity of methanolic extract of leaves of *O. sanctum* and *T. cordifolia* by DPPH free radical scavenging assay.

MATERIALS

For the present study *Ocimum sanctum* and *Tinospora cordifolia* plants growing in C.C.S.University Campus, Meerut were identified and used as experimental material.

*Ocimum sanctum*- Practically every part of the plant is useful. The plant is a mosquito-repellent. Decoction of roots is given as a diaphoretic in malarial fever. Leaves also used in cold, cough, fever and gastric disorders. The leaf infusion is used as a stomachic. The oil possesses antibacterial and insecticidal properties. The seeds are mucilaginous and demulcent and are used in genitor-urinary disorders.

*Tinospora cordifolia*- Seeds are taken as tonic. Aqueous extract of this plant is taken once a day, along with honey, for spermatorrhoea. Starch obtained from stem is mixed with equal quantity of
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sugar and taken for jaundice. Decoction of the stem of “giloe” and “neem” (Azadirachta indica), each taken in equal quantity is used during malarial fever. Decoction of the stem with cold or hot water empty stomach in the morning serves as a tonic in general debility.

METHODS

Standardization of extraction techniques:

Extraction Parameters:
Glass-ware and Equipment’s:
Vessels employed were test tubes and 20 ml borosil boiling test tube, 500 ml borosil round bottom flasks, pipette, micropipette, autoclave, mortar pestle, sonicator, spatula, water bath, electrical balance, centrifugation and spectrophotometer.

Cleaning of Glass-ware:
All glass wares used during experiments were cleaned with chromic acid solution and thoroughly washed with running tap water and sterilized in dry air oven at 60°C for 24 hours.

Chemicals:
Methanol, chloroform, ferric chloride solution, sulphuric acid, hydrochloric acid, acetic anhydride, potassium iodide, mercuric chloride ascorbic acid and DPPH (2,2-Diphenyl-1-picrylhydrazyl).

Collection of plant material:
Plant of Ocimum sanctum and Tinospora cordifolia were collected from residential area of employees of C.C.S. university (near Sir Choto Ram Engineering College, Meerut) and from Veer Siro Mani Maharana Pratap Singh Hostel. Different plant parts (Stem ad leaves) were taken for further studies.

Preparation of extract:
The fresh plant samples stem and leaf of O. sanctum and T. cordifolia were collected and washed individually under running tap water to remove soil particles and other dirt. The sample was air dried in the laboratory at room temperature for 10 days. All dried samples were grinded well into a fine powder by using mortar and pestle and stored in air tight polythene packets at room temperature before extraction. Extraction of the samples was prepared for phyto-chemical screening in chloroform and methanol solution by using water-bath, centrifugation and ultrasonication apparatus. Time required for each sample may vary under different condition of experimental apparatus.

Phytochemical screening:
Major phyto-compounds in the crude extracts of O.sanctum and T.cordifolia were subjected to phytochemical analysis to determine the presence of bioactive components by using standard qualitative methods (Trease and Evans 1996).
**Test for Alkaloids:**

1. **Dragendorff’s test:**

   1ml of plant extract was transferred into a test tube before adding a few drops of Dragendorff’s reagent (Potassium bismuth iodide). The formation of an orange precipitate was regarded as positive for the presence of alkaloids.

   **Preparation of Dragendorff’s reagent:** Potassium iodide + acetic anhydride + water

2. **Meyer’s test:**

   To 1ml of plant extract add 2ml of Meyer’s reagent (Potassio-mercuric iodide). The formation of a pale whitish precipitate shows the presence of alkaloids.

   **Preparation of Meyer’s reagent:** Meyer’s reagent is freshly prepared by dissolving the mixture of mercuric chloride and of potassium iodide in water.

**Test for Steroids:**

**Salkowski’s test:**

1ml of plant extract mixed with an equal volume of chloroform and treated with 2 ml of conc. Sulphuric acid. The development of a red precipitate confirmed the presence of steroids.

**Test for Tannins:**

**Ferric chloride test:**

To 1ml of plant extract added few drops of 0.1% ferric chloride and observed for brownish green or a blue-black colour.

**Test for Flavonoids:**

On addition of conc. HCl in plant extract of sample, appearance of red colour indicated the presence of flavonoids.

**Determination of Antioxidant activity:**

There are several *in vitro* methods available to assess the antioxidant activity of medicinal plants but no *in vivo* models for antioxidant activity instead in disease condition how plant can prevent the oxidation by scavenging the free radical generated which lead to that particular disease is determined.

**DPPH (2,2diphenyl-1-picrylhydrazyl) radical scavenging assay:**

**Mechanism of DPPH method:**

The molecule of DPPH is considered as a stable free radical by virtue of the delocalization of the spare electron over the molecule, so that the molecules do not dimerise. The delocalization also produce the deep violet colour, characterized by an absorption band in methanol solute centered at about 517 nm.
A is a free radical produced in this step. This latter radical will then undergo further reactions which control the overall stoichiometry, that is, the numbers of molecules of DPPH reduced (decolorised) by one molecule of reductant (Nariya et al., 2011).

**Preparation of DPPH:**
DPPH is a highly oxidizable compound. It oxidised in light, so DPPH is prepared in dark. Weigh accurately 1.9 mg DPPH and dissolved in methanol (0.1mM). Generally methanol is used but under certain cases ethanol is also used as a solvent for DPPH.

**Preparation of standard Ascorbic acid solution:**
Ascorbic acid is a strong anti-oxidizing agent. It is taken as standard. Standard solution of 1% ascorbic acid was prepared by dissolving 1 gm. of ascorbic acid in 100 ml of methanol.
Preparation of different concentration of *O. sanctum* and *T. cordifolia* leaves extract:
Different concentration of the test sample extract which is to be examined for antioxidant activity is prepared. Viz. 0.25gm/15ml, 0.50gm/15ml, 0.75gm/15ml and 1.00gm/15ml.

**Preparation of test sample:**
To 5ml of different concentration of each test sample was added 1ml of DPPH solution in dark.
Preparation of standard:
To 5 ml of 1% ascorbic acid solution was added 1ml of DPPH solution in dark.

**Incubation:**
The prepared solution of ascorbic acid and test sample was incubated for ½ half an hour.

**Measurement of absorbance:**
When procedure is done, than absorbance was taken with the help of U.V. Spectrophotometer at 517 nm.

**Calculation:**
Percentage (%) activity of individual concentration of individual extract was calculated by using the following formula:
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\[
% \text{Activity} = \frac{\text{Abs. of control} - \text{Abs. of individual concentration}}{\text{Abs. of control}} \times 100
\]

Where Abs. = Absorbance

RESULTS

Spot test was performed to detect the presence or absence of some secondary metabolite, present in stem and leaves extract of plant sample and found the following results:

Alkaloids- Positive
Flavonoids- Positive
Tannins- Positive
Steroids- Positive

The presence of alkaloids indicates that the use of the plants have harmless effect. The presence of flavonoids, confirms that the plant has high antioxidant value, as well as justify its anti-microbial, anti-inflammatory, anti-mutagenic, anti-viral and anti-allergic actions. Tannins are responsible for the hemostatic and anti-diarrheal properties (Asquith et al., 1986).

Table 1: Phytochemical screening of stem and leaf extracts of *O. sanctum* and *T. cordifolia* exhibited the presence of alkaloids, steroids, tannins and flavonoids:

<table>
<thead>
<tr>
<th>Plant metabolite</th>
<th>Test</th>
<th><em>Ocimum sanctum</em></th>
<th><em>Tinospora cordifolia</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Stem</td>
<td>Leaf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ME</td>
<td>CE</td>
</tr>
<tr>
<td>Alkaloids</td>
<td>Dragendorff’s test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Meyer’s test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Steroids</td>
<td>Salkowski’s test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Tannins</td>
<td>Ferric chloride test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>Conc. HCl</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

ME- Methanolic extract
CE- Chloroform extract

Using the spot tests, namely Dragendorff’s test, Meyer’s test for alkaloids, Salkowski’s test for steroids, Ferric chloride test tannins and Conc. HCl test for flavonoids.
Table 2: DPPH analysis of methanolic extract of leaves of *O. sanctum* and *T. cordifolia*:
Absorbance of Methanol extract of leaf of *Ocimum sanctum*:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Concentration (gm./ml)</th>
<th>Absorbance of test sample A_{517}</th>
<th>DPPH activity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control (1% ascorbic acid+0.1mM DPPH)</td>
<td>2.432</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.25</td>
<td>0.312±0.038</td>
<td>87.17%</td>
</tr>
<tr>
<td>3</td>
<td>0.50</td>
<td>0.474±0.015</td>
<td>80.51%</td>
</tr>
<tr>
<td>4</td>
<td>0.75</td>
<td>0.610±0.016</td>
<td>74.91%</td>
</tr>
<tr>
<td>5</td>
<td>1.00</td>
<td>0.449±0.024</td>
<td>81.53%</td>
</tr>
</tbody>
</table>

Table 3: Absorbance of Methanol extracts leaf of *Tinospora cordifolia*:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Conc. (gm./ml)</th>
<th>Absorbance of test sample A_{517}</th>
<th>DPPH activity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control (1% ascorbic acid+0.1Mm DPPH)</td>
<td>2.432</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.25</td>
<td>0.549±0.002</td>
<td>77.42%</td>
</tr>
<tr>
<td>3</td>
<td>0.50</td>
<td>0.623±0.029</td>
<td>74.38%</td>
</tr>
<tr>
<td>4</td>
<td>0.75</td>
<td>0.835±0.045</td>
<td>65.66%</td>
</tr>
<tr>
<td>5</td>
<td>1.00</td>
<td>0.389±0.028</td>
<td>84.00%</td>
</tr>
</tbody>
</table>

CONCLUSION
Plants contain a variety of phyto-chemicals compounds viz. Alkaloids, Flavonoids, Tannins and Steroids are among them. Due to the presence of these compounds, plants play important role in the treatment of various diseases and disorders. Result of DPPH analysis shows that lower the absorbance of the test sample leads to its higher DPPH activity.

ACKNOWLEDGEMENT
The author is thankful to my head of department Dr. Suman Verma and Prof. Y.Vimala (Botany department, CCS University Meerut) for providing all necessary facilities, support to conduct the experiment.

REFERENCES

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ROLE OF GREEN CHEMISTRY IN ENVIRONMENTAL SUSTAINABILITY

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ABSTRACT
Chemistry is generally considered as the prime reason for environmental degradation and pollution. But with adoption of green methods these effects can either be reduced or minimized. Green chemistry encompasses design and synthesis of environmentally benign chemical processes, green approaches to minimize and/or remediate environmental pollution, the development of biomaterials, bio-fuel, and bio energy production, biocatalysts, and policies and ethics in green chemistry. Green chemistry is a novel philosophical technique that makes use of a set of principles that aims to reduce/eliminate the use or generation of hazardous substances in the design, manufacture and application of chemical products. It is the best example of environmentally benign chemistry having a significant role in achieving environmental sustainability. With the help of green chemistry the approaches towards the renewable resources can be made increasingly viable technologically and economically. Green chemistry plays an essential in developing alternate sources of energy generation (hydrogen cell, fuels cells, biofuels, etc.). Using the environment technology we can conserve the natural environment and curb the negative impacts of human involvement. Implementation of green chemistry, design of chemical products and processes that eliminate the use and generation of hazardous substances, is essential if the expanding global population is to enjoy an increased standard of living without having adverse impact on the environment health. Green chemistry provides solutions to such global challenges as climate change likewise (soil pollution, water pollution and air pollution), sustainable agriculture, energy, toxics in the environment, and the depletion of natural resources. In its essence, green chemistry is a science-based non-regulatory and economically driven approach to achieving goals of sustainability, environmental and human health protection.

Keywords- Green chemistry, Eco-friendly and Sustainability etc

INTRODUCTION
The concept of greening chemistry is a relatively new idea which developed in the business and regulatory communities as a natural evolution of pollution prevention initiatives. In our efforts to improve crop protection, commercial products, and medicines, we also caused unintended harm to our planet and humans.

Green Chemistry or Sustainable Chemistry is defined by the Environmental Protection Agency (EPA) as "the design of chemical products that reduce or eliminate the use of hazardous substances" In recent years there is a greater societal expectation that chemists and chemical engineers should produce greener and more sustainable chemical processes and it is likely that
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this trend will continue to grow over the next few decades. The greening of chemistry depends upon the twelve basic principles-

**PRINCIPLES**

1. **Prevention**
   Prioritize the prevention of waste over clean-up and treatment once it’s created. This is based on the concept of “stop the pollutant at the source.”

2. **Atom Economy**
   Synthetic methods/reactions should be designed to maximize the incorporation of all materials used in the process into the final product, instead of generating unwanted side or wasteful products.

3. **Less hazardous chemical use**
   Wherever it is possible, production methods should be designed to make substances that are less toxic to people or the environment.

4. **Designing Safer Chemicals**
   Chemical products should be designed so that they not only perform their designed function but are also less toxic in the short and long term.

5. **Safer solvents and Auxiliaries**
   When making materials try not to use solvents or other unnecessary chemicals. If they are needed then they should not be harmful to the environment in any way.

6. **Design for Energy Efficiency**
   Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.

7. **Use of renewable feedstock**
   A raw material/feedstock should be renewable wherever possible. For example- oil, gas and coal are the major resources that cannot be replenished.

8. **Reduce Derivatives**
   Unnecessary derivatization (use of blocking groups, protection/ deprotection, temporary modification of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.

9. **Catalysis Reactions**
   Reactions that are catalysed are more efficient than uncatalysed reactions. Also the uses of heterogeneous catalysts have several advantages over the homogeneous catalysts.

10. **Design for Degradation**
    Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment. A complete life cycle analysis will be helpful in understanding its persistence in nature.

11. **Real-time analysis for Pollution Prevention**
    Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.
12. Inherently Safer Chemistry for Accident Prevention

Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

Five main points of focus emerge from the above said principles-

1. **less**, (uses fewer chemicals, solvents, and energy)
2. **safe**, (has safe raw materials, processes, and solvent)
3. **process-oriented**, (process should be efficient, without waste, without derivatization and should use catalysts)
4. **waste-reducing**, (waste generation should be monitored in real time and should degrade)
5. **sustainable** (all chemicals, raw materials, solvents and energy should be renewable)

![Figure - Key words in 12 principles of green chemistry](image)

In the following chapter we will proceed by taking four major topics of concern in green chemistry namely

a) Newer synthetic methods
b) Alternate solvents
c) Biocatalysts and
d) Industrial examples

**NEWER SYNTHETIC METHODS**

In this section we will see newer methods for kinetic activation of different molecules in chemical reactions. In order to minimize the energy and control reactions with a view to green
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chemistry, several attempts are being made to make the energy inputs in chemical system as efficient as possible.

Two different approaches are put forward-

1. **Classical methods,**
   a) Thermal
   b) Photochemical
   c) Electrochemical

2. **Non classical methods**
   a) Sonication/ sonochemical
   b) Mechanical
   c) Microwave

**ALTERNATE SOLVENTS**
A major concern with regards to sustainability is the release of various hazardous substances into the environment. Green chemistry can have a significant impact in this area. For this we will have to start with the thought of safer solvent.

**Organic Synthesis in Water**

Although water is considered a problem for organic synthesis and the purification processes and drying in final products is very cumbersome, in recent years water is considered a good solvent for organic reactions. The Diels-Alder reactions is a good example in which the hydrophobic properties of some reagents makes use of water an ideal solvent. As a solvent water accelerates some reactions because some reagent are not soluble and provides selectivity. The low solubility of Oxygen is also an advantage for some reactions where metal catalysts are used. In the last years water is used in many methods for organic reactions and the scientific literature has a large number of papers. Water appears to be a better option compared to others green solvents because of its abundant, non-toxic, non-corrosive, and non-inflammable nature.

In addition, water can be contained because of its relatively high vapour pressure as compared to organic solvents, making it a green and sustainable alternative. Recently, organic reactions in water without use of harmful organic solvents have drawn much more attention, because water is cheap, safe and environmentally benign solvent.

**Examples**

Some important organic reactions in aqueous media are presented below:

**Synthesis of pyrazolo[3,4-b]pyridines via multicomponent reaction**

A simple and an efficient synthesis of 4-aryl-3-methyl-1-phenyl-1H-benzo[h]pyrazolo[3,4-b]quinoline-5,10-diones was reported by Li-Qiang, W et al. by the one-pot condensation of 3-methyl-1-phenyl-1H-pyrazol-5-amine, aldehydes and 2-hydroxynaphthalene-1,4-dione in water in the presence of diammonium hydrogen phosphate (Figure below).
One-pot green synthesis for pyrimido [4,5-d] pyrimidine derivatives

Mazaahir, K et al. has been developed a very convenient as well as eco-friendly synthesis of pyrimido[4,5-d] pyrimidines in an aqueous medium without using any catalyst, i.e. completely circumventing the use of hazardous organic solvents and corrosive acids or bases from barbituric acid, aldehyde and urea or thiourea (Scheme V.A.2). Water-insoluble solid products obtained in short time are found to be essentially pure and are obtained in very high yield.

Green synthesis of hexa-hydro triazines under sonic condition

An efficient, clean and quick methodology for the synthesis of various 1,3,5-hexahydrotriazine derivatives with greater yields than the previously reported conventional methods has been developed by Ashish K Singh et al. from aryl amines, and formaldehyde under ultrasonic condition.
Novel synthesis of anilines by zinc metal-mediated chemoselective reduction of nitroarenes in water

Takehito T et al. have reported a simple and low cost procedure for reducing nitroarenes to the corresponding anilines using zinc metal and NH4Cl in water without any organic solvent at 80 °C (Scheme V.A.4) and this procedure is chemoselective for nitro groups. Ester, amide and halide substituents on aromatic rings are unaffected.

Supercritical carbon dioxide and supercritical water

A supercritical liquid is at a temperature and pressure above its critical point, where distinct liquid and gas phases do not exist. The supercritical liquid can effuse through solids like a gas, and dissolve materials like a liquid. In addition, close to the critical point, small changes in pressure or temperature result in large changes in density, allowing many properties of a supercritical fluid to be "fine-tuned". Supercritical liquids are suitable as a substitute for organic solvents in a range of industrial and laboratory processes. Carbon dioxide and water are the most commonly used supercritical fluids. Supercritical CO2 and water are considered “green” solvents in many industrial processes, providing high yields in many reactions, and there are many examples of their use in the scientific literature.

Organic Synthesis with Carbonic esters

Carbonic esters, such as DMC, dimethyl carbonate (CH$_3$OCOOCH$_3$) are considered a new class of “green” solvents in many organic reaction processes. They can replace
methychlorides and dimethyl sulphate esters which are toxic and hazardous. DMC can be used in methylation reactions of phenols, anilines and carboxylic acids. DBU is an alternative solvent that can be used for methylation reactions of phenols, indoles and benzimidazoles.

Catalyst

“Green” Catalysis under the Green Chemistry Principles

It is not only the “green” solvents that will change the face of synthetic organic reactions, but also the use of “green catalysts” will improve substantially the efficiency of many industrial processes. The use of catalysts is one of the principles of Green Chemistry. Catalysis is considered a cornerstone for innovative changes in chemical processes. Catalysts will affect energy use and reaction time, will increase yield, reduce use of solvents, and lower production of by-products and waste. Catalysis with “green” catalysts (which can be recycled) is considered a very important step in the direction of Green Chemistry for many industrial processes.

TECHNIQUES

Replacement of Toxic Solvents with Less Toxic Ones

The replacement of toxic or hazardous organic solvents in industrial processes and systems has been initiated long time ago. Examples, like replacement of benzene with toluene, cyclohexane instead of carbon tetrachloride, dichloromethane instead of chloroform etc. The scientific literature contains many examples and practices with replacement of the most toxic and hazardous solvents.

Microwaves in Organic Synthesis, without Solvents

We examined in the previous chapters the use of microwave furnaces for organic reactions. These techniques do not require solvents and are considered “greener” than the conventional methods. The wide range of applications of microwave chemistry has been extended recently to many aspects of organic synthesis. Catalysis under the Principles of Green Chemistry and Eco-friendly Synthesis are new innovative trends with substantial applications.

Sonochemistry in Organic Synthesis, without Solvents

Sonochemistry is also considered a methodology of organic reactions without solvents. Their use has been described before and it is obvious that their applications in organic chemistry will be extended further. High yields, low energy requirements, low waste, no use of solvents are some of the fundamental advantages of these sonochemical techniques.

Other “Greener” Techniques

In addition to the above methodologies which do not require solvents or use less solvents than the conventional methods, there are techniques of biocatalysis, self-thermo-regulated systems, soluble polymers, etc which are considered “green methodologies”. Green Chemistry covers all these aspects of eco-friendly methods and promotes their use in research laboratories and in industrial organic synthesis processes.

“Green solvents” from plants
Plants are considered a renewable sources of energy but also a resource for various materials. Plant oils or vegetable oils derive from plant sources. Unlike petroleum which is the main source of chemicals in the petrochemical industry they are renewable sources. There are three primary types of plant oil, differing both by the means of extraction and by the nature of the resulting oil: Vegetable oils can replace petroleum derived organic solvents, with better properties and more eco-friendly conditions as waste.

Chemists have advanced recently techniques so that some vegetable oils to become solvents and replace hazardous organic solvents. As an example of plant-based oils we selected the research project by Spear et al. on soybean oils and their esters. Vegetable oils can become a starting material for the production of eco-friendly solvents which are less toxic than the petrochemical industry’s organic solvents.

In the last decade, scientists are researching the use of “green” solvents in polymerization methods, since the polymer and plastics industries are using vast amounts of solvents. There have been some successful uses of alternative solvents in polymerization under the principles of Green Chemistry. Polymers can be prepared under industrial scale production with the use of eco-friendly solvents. All these techniques aim at replacing toxic and hazardous solvents in many chemical processes in the synthetic laboratory and in the chemical industry.

CONCLUSION

Application of any single techniques for any synthesis is not possible. But each organic synthesis have a alternative and green method. Main aim of this article is to understand different types of availability of green solution for organic synthesis and need of green synthesis in present era. All mentioned techniques aim at replacing toxic and hazardous solvents in many chemical processes in the synthetic laboratory and in the chemical industry. Also there have been some successful uses of alternative solvents in polymerization under the principles of Green Chemistry.
VIRUS – VECTOR RELATIONSHIP 
(Based on length of temperature for which an insect remain viruliferous)

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IMPORTANT TERMS
1. Acquisition feeding period
   It is the time for which a virus free vector actually feeds on a virus infected plant to acquire the virus.
2. Acquisition access period
   It is the time for which a vector is allowed to feed on a source of virus.
3. Viruliferous vector
   Vector become able to transmit the virus. Generally, vector become viruliferous immediately after acquiring the virus in sufficient quantities from the diseased plant or there may be a waiting or latent period before the virus can be transmitted.
4. Inoculation access period
   It is the time for which the vector after acquiring the virus is allowed to feed on a healthy plant to transmit virus.
5. Inoculation feeding period
   The actual period of feeding to inoculate the virus is called as inoculation feeding period.
6. Transfer time/transmission threshold period
   Minimum period of time that a virus needs for acquisition and subsequent transfer to a virus free plant is called as transfer time.

On the basis of length of time for which of insect vector remains viruliferous, they are classified as 1) Persistent (2) Semi persistent and (3) non persistent viruses.

1) Persistent virus
   In case of persistent virus, the relationship is highly specific and the virus have an intimate biological relationship with the vector. Immediately after acquiring the virus the virus may be circulated through alimentary canal, gut wall and body fluid of the insect. Such virus have a latent period in vector body and persist for long in the vector. Molting has no effect on persistence such viruses are usually present in phloem of host cell and have long acquisition and inoculation feeding period. So they are also called as circulative virus sometimes the virus itself multiplies inside the vector body and they are called as circulative propagative virus. Certain viruses are carried/ transferred to the progeny of vector such as eggs and are called as transovarial transmission. For example in paddy, the rice dwarf virus is transmitted to the egg masses of leaf hopper Nephotettix cineticeps.
2. **Non persistent virus**

The acquisition and inoculation feeding period of such virus are usually few second and they do not have any latent period in the vector. Such virus are mechanically transmitted and are lost by the vector during molting.

3. **Semi persistent virus**

They have characters of both persistent and non persistent viruses. They have long acquisition feeding period to acquire virus from phloem of the host plant but the vector become immediately viruliferous without latency. Such virus persist in the vector of few days and are lost at motting. They are not circulated in the vector body.

**Vector**: any organism that carry diseases causing pathogen.

**Difference between persistent and non-persistent virus**

<table>
<thead>
<tr>
<th>Persistent virus</th>
<th>Non persistent virus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The vectors retained the virus in their body throughout the life</td>
<td>The virus are retained only for a short period in the body of vector</td>
</tr>
<tr>
<td>2. Viruses are retained even after moultng</td>
<td>Virus are lost form insect vector one the insect moultls</td>
</tr>
<tr>
<td>3. Acquisition feeding period is long (2 hrs)</td>
<td>Acquisition feeding period is short i.e. minimum of 15 sec. is enough</td>
</tr>
<tr>
<td>4. There is latent period in vector</td>
<td>No latent period in the vector</td>
</tr>
<tr>
<td>5. Long incubation period in the vector</td>
<td>Only short incubation period</td>
</tr>
<tr>
<td>6. Virus can multiply in the vector body i.e.</td>
<td>Do not multiply inside the vector</td>
</tr>
<tr>
<td>circulating and propagative</td>
<td></td>
</tr>
</tbody>
</table>

The insects involved in the viral transmission are dealt in detail hereunder.

i. **Aphids**

Aphids are the most important insect vectors known to transmit more than 250 plant viruses. Aphids may transmit the viruses in a persistent (circulative, non propagative and circulative propagative), semi persistent and non persistent way some time the non persistent way of transmission is called as stylet borne viruses. The viral pathogen that are transmitted through aphids are tested below.
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<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Virus</th>
<th>Vector</th>
<th>Type of transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Bean common mosaic virus</td>
<td><em>Aphis craccivora</em></td>
<td>Non-persistent</td>
</tr>
<tr>
<td>2.</td>
<td>Citrus tristeza virus</td>
<td><em>Toxoptera citricidus</em></td>
<td>Non-persistent</td>
</tr>
<tr>
<td>3.</td>
<td>Potato virus Y</td>
<td><em>Myzus persicae</em></td>
<td>Non-persistent</td>
</tr>
<tr>
<td>4.</td>
<td>Barley yellow dwarf</td>
<td><em>A. dirhodum</em></td>
<td>Persistent</td>
</tr>
<tr>
<td>5.</td>
<td>Banana Bunchy top</td>
<td><em>Pentolonia nigronervosa</em></td>
<td>Persistent</td>
</tr>
<tr>
<td>6.</td>
<td>Beet yellows</td>
<td><em>M. Persicae</em></td>
<td>Semi persistent</td>
</tr>
<tr>
<td>7.</td>
<td>Cardomum dwarf</td>
<td><em>Micromyzus klimpongense</em></td>
<td>Persistent</td>
</tr>
<tr>
<td>8.</td>
<td>Cardomum mosaic virus</td>
<td><em>Pentalonia nigronervosa</em></td>
<td>Non persistent</td>
</tr>
<tr>
<td>9.</td>
<td>Cauliflower mosaic virus</td>
<td><em>Brevicorgne brassicae</em></td>
<td>Semi persistent</td>
</tr>
</tbody>
</table>

#### b) Leaf hoppers and plant hoppers

They rank second in transmitting when compared with aphids, they penetrate tissues more rapidly and cause more damage to cells virus. Most of the leaf hopper borne viruses are transmitted in a persistent manner (Cerculatus and propagative) except few viruses like Rice tungro virus of and maize chlorotic dwarf virus which is transmitted in a semi persistent way. Some of the examples of leaf hopper transmitted virus are:

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Virus</th>
<th>Type of transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Nephotettix virescens</em></td>
<td>Rice tungro virus</td>
</tr>
<tr>
<td>2.</td>
<td><em>Cicadulinia cinai</em></td>
<td>Maize streak virus</td>
</tr>
<tr>
<td>3.</td>
<td><em>Nilaparvatha lugens</em></td>
<td>Rice grassy stunt virus</td>
</tr>
<tr>
<td>4.</td>
<td><em>Circulifer tenellus</em></td>
<td>Beet curly top virus</td>
</tr>
<tr>
<td>5.</td>
<td><em>Agallia constricta</em></td>
<td>Potato yellow dwarf</td>
</tr>
<tr>
<td>6.</td>
<td><em>Graminellus nigrifrons</em></td>
<td>Maize chlorotic dwarf virus</td>
</tr>
<tr>
<td>7.</td>
<td><em>Laodelphax striatellus</em></td>
<td>Rice stripe virus</td>
</tr>
<tr>
<td>8.</td>
<td><em>Nephotettix cincticeps</em></td>
<td>Rice dwarf</td>
</tr>
<tr>
<td>9.</td>
<td><em>Sogatodes oryzicola</em></td>
<td>Rice hoja blanca virus</td>
</tr>
<tr>
<td>10.</td>
<td><em>Perkinsiella saccharida</em></td>
<td>Sugarcane Fiji virus</td>
</tr>
</tbody>
</table>

Among this, except rice tungro and maize chlorotic dwarf virus all are circulation and they require feeding period of one to several days before they become viruliferous but once days before they become viruliferous but once they have acquired virus they may remain viruliferous for the rest of their lives. transovarial type of transmission is noticed in rice dwarf virus.
iii) White fly

Nymphs and adults of whiteflies transmit the viruses in a circulative and non propagative manner. Virus that are transmitted through whit flies are economically important in tropical area and to a lesser extent in subtropical and temperate areas.

Many of the gemini viruses and some viruses belonging to earla virus, clostero virus, luteo virus, nepo virus and poty virus group are transmitted by white fly. Only three sps of whiteflies have been reported as vector of plant viruses of which *Bemisia tabaci* is the vector for many mosaic and leaf distortion symptom in infected plant. They usually need longer acquisition period than inoculation feeding period. The vectors mainly feed on phloem of the host plant and hence the virus are not sap transmissible. Some of the whitefly transmitted viruses are

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Virus</th>
<th>Vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cassava mosaic virus</td>
<td><em>Bemisia tabaci</em></td>
</tr>
<tr>
<td>2.</td>
<td>Bhendi vein clearing virus</td>
<td><em>Bemisia tabaci</em></td>
</tr>
<tr>
<td>3.</td>
<td>Cotton leaf curl, virus</td>
<td><em>Bemisia tabaci</em></td>
</tr>
<tr>
<td>4.</td>
<td>Mungbean leaf curl virus</td>
<td><em>Bemisia tabaci</em></td>
</tr>
<tr>
<td>5.</td>
<td>Tobacco leaf curl virus</td>
<td><em>Bemisia tabaci</em></td>
</tr>
<tr>
<td>6.</td>
<td>Beet pseudo yellow virus</td>
<td><em>Trialeurodes vaporariorum</em></td>
</tr>
</tbody>
</table>

iv) Thrips

The unique characters of thrips as vector of plant virus is that only nymphs can acquire the virus and can remain viruliferous till death. They transmit the virus in a persistent and circulative manner and causes necrosis, bronzing and rosette type of symptom in plants. The species of thrips involved in virus transmission are *thrips tabaci*, *Thrips palmi*, *T. setosus*, *Frankliniella schultzei*, *F. fusca*, *F. occidentalis*, *Scirtothrips dorsalis*. The viruses transmitted by thrips include tomato spotted with virus (Tospo virus) tobacco ringspot virus (Nepo virus) and Tobacco streak virus (illar virus).

v) Mealy bug

Nymphs are more effective vectors than adults. Nineteen sps of mealy bug belonging to Pseudococcidae are reported to transmits six viruses in a semi persistent manner. Though they are phloem feeders, their efficacy in transmission of virus is comparatively less because they are not particularly mobile and rely on crawling to move from plant to plant. Some of the important mealy bud transmitted virus are listed below.
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<table>
<thead>
<tr>
<th>1.</th>
<th>Cocoa swollen shoot virus</th>
<th>Planococcoids njalensis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cocoa swollen shoot virus</td>
<td>Planococcus citri</td>
</tr>
<tr>
<td></td>
<td>Cocoa swollen shoot virus</td>
<td>P. celtis, P. kenya</td>
</tr>
<tr>
<td>2.</td>
<td>Pineapple wilt virus</td>
<td>Dysmicoccus brevipes</td>
</tr>
</tbody>
</table>

vi) Beetles

In contrast to aphids, thrips and whiteflies, beetles have chewing and biting mouthparts transmit four major group of viruses includes bromovirus, comovirus, tymovirus and sobemovirus. Usually the beetle transmitted viruses do not have no other vectors or only to a limited extent by others. The mode of transmission is persistent and circulative and there is not evidence for the propagation of virus inside the vector body. Fr example cowpea mosaic virus and southern bean mosaic virus are transmitted by ceratoma trifurcata. Squash mosaic virus by Diabrotica longicomis turnip yellow mosaic virus by psylloides sp: radish mosaic virus by Epitrix hirtipennis, Bhendi mosaic virus by Podagria sp, Broad bean stain virus by Sitona lineata and Bean pod motle virus by Epicauta vittata.

vii) Other insects

Other than these insects, some bugs, grasshoppers, earwigs, leaf miner are also reported to transmit some viral disease.

Grasshopper

Melanoplus differentialis - Potato virus x Tobacco mosaic virus

Earwig

Focicula auricularia - Turnip yellow mosaic

Plant bug

Lygus protensis - Spinach blight virus

Lace bug

Piesma quadratum - Beet leaf curl virus

Lygaeid bug

Nysius sp - Centrosima mosaic virus

Leaf miner

Liriomyza langei - Sowbane mosaic virus

Though the insects carry the viruses at great cost the virus may affect some vectors also to a limited extent. For example leaf hopper delphacodes pellucida carrying the wheat striate mosaic virus have lesser progeny and have a shorter life.

g) Transmission by mites

Among them, the eriophyid mites and spider mites have been shown to be vectors of plant viruses. Nine viruses are reported to be transmitted by seven different species of mites in a persistent ciruclative manner. The eriophid mites do not have much movement and are easily carried by wind because of their size 9about 0.2 mm long and tiny). They have puncturing and
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**h) Transmission by nematodes**

Soil inhabiting ectoparasitic nematodes transmit approximately 20 soil borne plant viruses whose infectivity will be lost when soil is allowed to dry at 20 °C for a week. Raski and Goheen (1968) for the first time proved the association of *Xiphinema index* as the vector for the grapevine fan leaf virus. Four genera of nematode belonging to Doriplaimoidea are known as vector of plant virus which are either polyhedral tubular. The nematode transmitted viruses are broadly divided into two groups.

1. **NEPO** (Nematode transmitted polyhedral viruses)

2. **NETU/TOBRA virus** (Nematode transmitting tubular viruses)

NEPO viruses are vectored by *Xiphinema* sp. *Longidorus* sp and *Paralongidorus* sp. and NETU/TOBRA viruses are transmitted by species of *Trichodorus* and *Paratrichodorus*. Transmission of viruses by nematode resembles the transmission by insects NEPO virus are isometric with angular outlines of 23-30 nm. Whereas NETU viruses are straight tubular and rigid. Both NEPO and NETU are having bipartite genome with ssRNA, sap inoculated, seed (or) pollen transmitted and have moderate to wide host range. *Xiphinema* are transmitting the virus in a circulative manner while *Longidorus* transmits in a non persistent way. Regarding NETU/TOBRA virus some virus are considered circulative where as the some of the strain of the same virus may be non persistent.

**Examples of nematode transmitted viruses :**

**NEPO virus**

<table>
<thead>
<tr>
<th></th>
<th><em>Xiphinema</em> index</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>X. americanum</em></td>
<td>Tomato ringspot virus, (Tom RV)  Tobacco ringspot virus, (Tob RV)  peach rosete mosaic virus (PRMV)</td>
</tr>
<tr>
<td>2.</td>
<td><em>X. bakeri</em></td>
<td>Arabis mosaic virus (AMV)</td>
</tr>
<tr>
<td>3.</td>
<td><em>X. brevicolle</em></td>
<td>Tomato ringspot virus (Tom RV)</td>
</tr>
<tr>
<td>4.</td>
<td><em>X. coxi</em></td>
<td>Cherry leaf roll virus (CLRV)  Tobacco ringspot virus (Tom RV)</td>
</tr>
<tr>
<td>5.</td>
<td><em>X. diversicandatum</em></td>
<td>CLRV, GFV, Cowpea mosaic virus</td>
</tr>
<tr>
<td>6.</td>
<td><em>X. italica</em></td>
<td>GFV</td>
</tr>
<tr>
<td>7.</td>
<td><em>Rivesi</em></td>
<td>Tom RV</td>
</tr>
<tr>
<td>8.</td>
<td><em>Longidorus elongatus</em></td>
<td>Tomato black ringspot virus (TBRV), CLRV</td>
</tr>
</tbody>
</table>

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11. L. martini  Prunus necrotic ringspot virus Mulberry ringspot virus
12. Paratongidorus maximus  CLRV

**NETU/TOBRA VIRUSES**

<table>
<thead>
<tr>
<th></th>
<th>Paratrichodorus allius</th>
<th>Tobacco rattle virus (TRV)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2)</td>
<td>P. minor</td>
<td>Tobacco rattle virus (TRV) Pepper ringspot virus</td>
</tr>
<tr>
<td>3)</td>
<td>P. teres</td>
<td>Pea early browning virus (PEBV)</td>
</tr>
<tr>
<td>4)</td>
<td>P. Porosus</td>
<td>TRV</td>
</tr>
<tr>
<td>5)</td>
<td>Trichodorus cylindricus</td>
<td>TRV</td>
</tr>
<tr>
<td>6)</td>
<td>T. hopperi</td>
<td>TRV</td>
</tr>
<tr>
<td>7)</td>
<td>T. similis</td>
<td>TRV</td>
</tr>
<tr>
<td>8)</td>
<td>T. viruliferus and T. primitivus</td>
<td>PEBV</td>
</tr>
</tbody>
</table>

* TRV causs spraing disease in potato.

**i) Transmission through fungi**

Fungi belong to the family plasmodiophoraceae, olpideaceae and synchytriaceae transmit soil borne viruses that survive for long period in dry soil condition. These obligate fungi infect the host root by zoospores resting spore which carry the virus externally or internally and thus transmit the virus the persistence of virus depends on longivity of the resting spores of the fungi. Olpidium brassicae transmits tobacco necrosis virus, tobacco stunt virus lettuce big vein virus. O. curcurbilacearum transmits cucumber necrosis virus. The species of Olpidium carries the virus particles only on the surface of zoospore and not on resting spores. In contrast, species of Polymyxa and spongospora transmits the virus particles through their resting spores. The viruses are get acquired during the colonization of virus infected plants and remain viable in the resting spores. Whenever these resting spores germinate, the virus is transmitted by zoospores into new roots. Some of the suitable examples under this category are (1) Polymyxa graminis (transmit Barley yellow mosaic, oat mosaic, wheat soil borne mosaic and wheat spindle streak mosaic) (2) P. betae (transmit Beet necrotic yellow vein or rhizomania of sugar beet) (3) Spongospora subterranea (transmits potato mop top).

**Man**

Involvement of human being in virus transmission over short or long distance is highly significant as he did in fungi and bacterial dispersal. Majority of horticultural crops are being
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Vegetatively propagated and he may be responsible for the transmission of virus during grafting, planting bulbs and corms cutting or by planting virus infected plants.

REFERENCES

Biological seed treatments for management of seed and seedling diseases recommend the grower an alternative to chemical fungicides (Oerke 2006). Even biological seed treatments can be extremely effective, it must be documented that they differ from chemical seed treatments by their employment of living microorganisms (Glare et al. 2012). Storage and application conditions of biological agents are more critical than with chemical seed protectants and differential reaction to hosts and environmental conditions may cause biological seed treatments to have a narrower spectrum of use than chemicals. On the contrary, some biocontrol agents applied as seed dressers are capable of colonizing the rhizosphere, potentially providing benefits to the plant beyond the seedling emergence stage (Philippot et al. 2013). Seed treatment with biocontrol agents along with priming agents may serve as an important means of managing many of the soil- and seed-borne diseases, the process often known as ‘bio priming’.

**PROCEDURE OF SEED BIO PRIMING**

- Pre-soak the seeds in water for 12 hours.
- Mix the formulated product of bio agent (*Trichoderma harzianum* and *Pseudomonas fluorescens*) with the pre-soaked seeds at the rate of 10 g per kg seed.
- Put the treated seeds as a heap.
- Cover the heap with a moist jute sack to maintain high humidity.
- Incubate the seeds under high humidity for about 48 h at approx. 25 to 32°C.
- Bioagent adhered to the seed grows on the seed surface under moist condition to form a protective layer all around the seed coat.
- Sow the seeds in nursery bed.
- The seeds thus bioprimed with the bioagent provide protection against seed and soil borne plant pathogens, improved germination and seedling growth.

**HISTORY OF BIOPRIMING:**

The well known example of seed inoculation is evidently that of legume seeds which aims to maximize yield potential by providing high numbers of viable rhizobia to the root microclimate to allow rapid colonization, nodulation and atmospheric nitrogen (N2) fixation by a selected inoculant strain. For many legume crops, inoculation with the correct rhizobial partner is essential for crop establishment where the required strain is not present in soil. By the end of the nineteenth century, the practice of mixing “naturally inoculated” soil with seeds became a...
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suggested method of legume inoculation in the USA and the first patent “Nitragin” for plant inoculation with *Rhizobium sp.* was registered in 1896 (Bashan 1998). The legume inoculants industry is nowadays well established, also a wide range of inoculants are available around the world and legume inoculation can be considered “the success story” of applied soil microbiology.

**Biopriming mediated enhancement of nutrient use efficiency:**

Some plant related microbes and soil micro-organisms are involved in plant growth enhancement and known as “biofertilisers”. They act by increasing the availability of nutrients in the rhizosphere of plants. Concern over security of supply and fluctuating costs of phosphorus fertilizers has resulted in increased interest in microorganisms that aid plant uptake of phosphorus (P) from soil.

Microbes play essential role in soil nutrient cycle through mobilization and uptake. Soil health and nutrient pool status depend on function and structure on microbial communities residing in it.

Most of the chemical fertilizers applied to the soil are not available to the plants and wasted through run off and leaching. Less efficient use of fertilizers is one of reason for the high cost of production. This is a serious issue in environmental problems particularly problem soil such as soil acidification, ground water contamination and N₂O emission. Therefore, maintaining agricultural productivity in such a way that minimizes the harmful effects of fertilizers on environment is need of the present hour. Various techniques have been advocated to increase the nutrient use efficiency. Microorganisms are also reported to enhance the nutrient use efficiency. The presence of microorganisms in rhizosphere influences the nutrient availability to the plants (Vessey 2003). *Trichoderma spp.* plays a vital role in nutrient recycling and their availability to the plants. Application of *Trichoderma spp.* facilitates the nitrogen use efficiency in plants. Seed biopriming with *Trichoderma spp.* can reduce the nitrogen requirement by the extent of 30- 50%. Role of *Trichoderma spp.* in solubilization tricalcium phosphate and other phosphorus has been well investigated and results indicated the enhanced availability of P to the plants (Richardson and Simpson 2011).

**Disease control**

Biocontrol agents (BCAs), such as Trichoderma, Pseudomonas and Bacillus can control plant disease but are also demonstrated to be an enhancer of plant growth. Root rhizosphere acts as home for a vast range of microbial community and allows them to interact all together with plants. Fact that compatible microorganisms in soil can work together encourages the use of “microbial consortium” rather than only single microorganisms (Errington 2003; Yanez-Mendizabal et al. 2012). Synergistic effect of microbial consortium may provide better plant growth and abiotic stress tolerance in plants. Microbial consortium may also provide augmented elicitation of resistance responses in plant against wide range of soil and seed borne pathogens.
Consortia of T. harzianum TNHU27, P. aeruginosa PJHU15 and B. subtilis BHUU100 were evaluated for their biocontrol and plant growth activities in pea challenged with *Sclerotinia sclerotiorum* which causes Sclerotinia stem and pod rot. The consortium of selected microbes showed significant 1.5-2.5 times increase in defensive actions in treated plants in comparison to pathogen infected plants. Causes are as follows:

1. Plant microbe interaction led to the induction of antioxidant enzymes in plant cells which ensure protection from the oxidative stress generated after pathogen infection. Beneficial microorganisms also improve reactive oxygen species management in plants. Consortium of P. aeruginosa PJHU15, T. harzianum TNHU27, and B. subtilis BHUU100 were reported to suppress the infection of *S. sclerotiorum* in pea by altering hydrogen peroxide ($H_2O_2$) and ascorbic acid production, lipid peroxidation and antioxidant enzymes (Minaxi et al. 2012). Increased production of H2O2 after 24 h of pathogen challenge was recorded in the triple consortium treated plants, in comparison to untreated plants. Similarly, enhanced activity of ascorbate peroxidase, catalase, guaiacol peroxidase, glutathione peroxidase and lipid peroxidation was also recorded after 24 and 48 h of pathogen challenge. Highest activities of phenylalanine ammonia lyase (PAL) and polyphenol oxidase (PPO) and maximum accumulation of phenolic content were observed in triple microbe consortium treated plants challenged with the pathogen. Likewise, antioxidant enzymes including peroxidase and superoxide dismutase were expressed highest in same treatment.

2. Furthermore, maximum lignification in vascular bundles was observed in consortium treated plants. Experiments results suggested an amplified elicitation of defense responses in host under pathogen infection by microbial consortium. The microbial strains of Mesorhizobium sp. RL09, Pseudomonas aeruginosa PHU094 and Trichoderma harzianum THU0816 strain were facilitated redox homeostasis in *Cicer arietinum* under the challenge of *S. rolfsii* (Rosas et al. 2006; Valverde et al. 2006).

3. Similarly, high amount of phenolic compounds were accumulated in leaf and collar region of *S. sclerotiorum* infected plants compared to unchallenged plants. Among the phenolic compounds quercetin, t-chlorogenic acid, shikimic acid, myricetin, ferulic acid and syringic acid were produced in higher amounts in collar region and leaves. Consortia of beneficial microbes also have reported improving nutritional value of plant products.

4. Alteration in proteomic profile and enhanced resistance against *S. sclerotiorum* in pea plant was observed in comparative proteomic study of pea plant treated with microbial consortia. Total 30 proteins were differentially increased or decreased in 2-DE gels analysis of pea leaves. 25 proteins were identified by MALDI-TOF MS and classified into various categories such as respiration, photosynthesis, protein synthesis, phenyl propanoid metabolism, carbohydrate metabolism, nitrogen metabolism, stress regulation and defense-related processes. The proteomic analysis of defense response in pea plant against *S. sclerotiorum* highlighted the enhanced protection offered by microbial consortia in pathogen challenged plants.
Bionematicides:-

Nematicidal microorganisms have been used as seed priming agents and one of the examples of a commercially accessible biological seed treatment is the nematicidal bacterium *Bacillus firmus*. The active ingredient in the product is PONCHO/VOTiVO (Bayer Crop Science 2016). This was originally a stand-alone product, but *B. firmus* is now most commonly used as a seed treatment in combination with the insecticide clothianidin (Poncho). This product is used for control of insect pests and plant parasitic nematodes on a range of crops including corn, cotton, sorghum, soybean and sugar beet. As a spore-former, *B. firmus* is well suited to withstand the stresses associated with commercial seed treatment processes with the company claiming 2 years product stability under cool dry conditions. A range of other nematicidal microorganisms are used commercially but delivery is generally via dry granules or granules that can be dissolved and applied as sprays or through irrigation systems. *Pasteuria spp.* are also well recognised as endospore-forming bacterial endoparasites of plant parasitic nematodes. While difficult to mass produce, *Pasteuria spp.* has established potential as a seed treatment for control of reniform shaped nematodes: population control was comparable to a seed-applied nematicide/insecticide (thiodicarb/imidacloprid) at a seed coating application rate of $1.0 \times 10^8$ spores/seed (Schmidt et al. 2010).

Control of weeds:-

Seed application could be a useful method for delivery of bio-herbicides into cropping systems. This approach requires that the bio-herbicide inoculants initially colonizes roots emerging from the seed of the crop plant, and then colonizes the rhizosphere of adjoining target weeds to a level that inhibits growth of the target weed. Proof-of-concept for this approach has been demonstrated. Downy brome (*Bromus tectorum*) causes significant yield reductions in wheat and rhizobacteria strains (*Pseudomonas putida, Stentotrophomonas maltophilia, Enterobacter taylori*) capable of inhibiting root elongation or seed germination of downy brome have been identified (Kennedy *et al.* 1991). Following application to wheat seeds, these bacterial strains successfully colonized the downy brome rhizosphere and reduced the competitive ability of the weed under glasshouse conditions.

Improved stress tolerance of crops:-

Drought stress is an important factor which is governing as well as limiting crop production in many arid and semi-arid areas of the world and is gradually increasing under current climate change predictions. There is renewed interest in plant-associated microorganisms capable of ameliorating plant stress via a wide range of mechanisms that span modification of plant hormone levels and production on bacterial exo-polysaccharides. For example, a strain of *Pseudomonas putida* (selected for its ability to survive at low soil moisture potential) colonized the rhizoplane, soil adhering to sunflower roots and increased the percentage of stable soil
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aggregates. Increased plant biomass and stress tolerance was attributed to plant growth-promoting compounds produced by the bacteria within the bio-film that it produced on the roots of the seedlings and through production of exo-polysaccharide which increased soil aggregation, thereby maintaining higher water potential around the roots. This is a novel approach to increasing stress tolerance in plants.

Seed treatment with salinity or drought tolerant isolates of *Trichoderma harzianum* reduced the severity of stress in wheat plants (Shukla *et al.*, 2015) under laboratory and greenhouse conditions. Seed treatment with *T. harzianum* has also improved seed germination under osmotic and salt stress and under suboptimal temperatures in the laboratory by reducing the damage caused to the stressed plant by accumulation of toxic reactive oxygen species. Priming of Styrian oil pumpkin seed with bacterial endophytic strains (Serratia plymuthica and Lysobacter gummosus) improved desiccation tolerance of the plants in the field (Furnkranz *et al.* 2012).

CONCLUSION

Microbial aggregation of agriculturally important microorganisms increases plant’s resistance against broad range of plant pathogens through enabling plant to regulate its defense response by communicating in a synergistic manner. Enhanced protection from oxidative stress is the most reasonable explanation of the beneficial effects that plant growth-promoting rhizospheric microbes have on host plants, because oxidative stress or production of reactive oxygen species are the connecting link between all the stresses. The antioxidant enzymatic activities offer an alternative mechanism that is observed in plant-microbe defensive mutualism, as these active oxygen species act as signaling molecules. Application of various agriculturally important microorganisms in agriculture has provided a safer alternative to the hazardous agrochemicals, which can make reduction in pollution of environment as well as cost benefit ratio will be lowered. But proper knowledge and skill is necessarily important. Seed biopriming with biocontrol agents proved to be efficient technology for protection from soil and seed borne diseases. This protection is in general non- significantly dissimilar from protection provided by chemical pesticides as it also enhances seed germination and vegetative growth. Effectiveness of seed biopriming have been experimented and reviewed by various researchers and now it could be suggested that combined application of hydro-priming and seed coating with biocontrol agents would be a excellent substitute to the chemical seed treatment. Additionally, it has explored a new dimension of biocontrol and could be exploited by agricultural industries and organic farmers in sustainable agriculture.

REFERENCES

IMPACT OF CLIMATE CHANGES ON ANIMAL PRODUCTION AND SUSTAINABILITY OF LIVESTOCK SYSTEMS

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ABSTRACT

It is true that most proportions of Indian livestock production and productivities are declined when the climate condition is not comfortable. The climate change especially global warming may highly influence production performance of farm animals throughout the world. This is on the background that the impact of climate change on crops is well known, much less is known about the impact of climate change on livestock. Unfortunately, livestock production and productivities assumes an overriding emphasis as one of the core sectors to solve the current food challenges and bringing future food sustainability in developing countries. Out of all the factors influencing livestock production, climate, and location are undoubtedly the most significant. Climate change will have far-reaching consequences for animal production, especially in vulnerable parts of the world where it is vital for nutrition and livelihoods. The impact of climate change can heighten the vulnerability of livestock systems and exacerbate existing stresses upon them, such as drought. Parasites and diseases are among the most severe factors that impact livestock production and productivity. Animal diseases have great impact on food supplies, trade and commerce, and human health globally. Animal genetic diversity is critical for food security and rural development. It allows farmers to select stocks or develop new breeds in response to changing conditions. Keywords: Impact, Livestock, Climate, Production.

INTRODUCTION

The income generated by livestock rearing such as dairy cattle, beef cattle, sheep, goat and chickens. In most rural communities livestock is the only asset of the poor. But it is highly susceptible to climate variability extremes. The effect of climate change is anticipated to heighten the susceptibility of livestock system and reinforce the existing factors that are affecting livestock production systems. Livestock production is the world’s dominant land use, covering about 45% of the Earth’s land surface, and much of it in harsh and variable environments that are unsuitable for other purposes. Climate change can impact the amount and quality of produce, reliability of production, and the natural resource base on which livestock production depends. Climate is an important factor of agricultural productivity and climate change is expected to severely impact livestock production systems. Furthermore, global demand for animal protein will rise as populations become more affluent and eating habits change. Climate change will have far-reaching consequences for dairy, meat, and wool production systems that rely primarily on grass and rangelands and this will likely detrimentally affect vulnerable pastoral communities which are engaged in extensive livestock production systems in dry lands.
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Climate change is actually the most important environmental issue of any time. With severe and widespread destructive effects, warming of the planet threatens ecological systems, peoples’ livelihoods, and species survival. Animal production under agriculture is an important source of greenhouse gas (GHG) emissions and has been implicated as a serious contributor to climate change. The climate impacts anticipated for developing country are similar to those being experienced around the world: general warming (day and night temperatures all year round); changes in rainfall timing and quantities; changes in seasons (longer summers); increased climate variability (e.g. floods, droughts and heat waves); higher sea-levels; and increasing frequency and intensity of extreme weather events (IPPC, 2007).

India has possessed the largest livestock population. Huge increase in the demand of animal production is expected in the next decades. Food and water security will be one of the other priorities for humankind in the 21st century. Over the same period the World will experience a change in the global climate that will cause shifts in local climate that will impact on local and global agriculture. The key conclusions of Working Group I of the Intergovernmental Panel on Climate Change (IPCC), the Fourth Assessment Report (AR4) (IPCC, 2007) were: a) warming of the climatic system is unequivocal b) Anthropogenic warming will probably continue for centuries due to the timescales associated with climate processes and feedbacks and c) The surface air warming in the 21st century by best estimate will range from 1.1 to 2.9 °C for a “low scenario” and of 2.4 to 6.4 °C for a “high scenario”. Moreover, the IPCC report estimates a confidence level >90% that there will be more frequent warm spells, heat waves and heavy rainfall and a confidence level >66% that there will be an increase in drought, tropical cyclones and extreme high tides.

Animal Production: The impact of heat and humidity on animal physiology is well documented. Extreme heat generally results in higher animal mortality, but, possibly of greater concern is the important are the economic impacts to production such as daily weight gain and feed conversion efficiency. Heat and humidity can also impact an animal’s immune system making it more susceptible to disease and stress. In addition to direct effects on animal production, heat, humidity, and moisture drive pest and disease cycles. These changes can be spatial, temporal or change the intensity of the outbreak.

The magnitude of the events will vary depending on the geographic zones of the World. The effects of global warming will not be adverse everywhere in the world. Thornton et al. (2007) forecast a slight increase in crop productivity at mid to high latitude for an increased local mean temperature of 1-3 °C. Also in these areas, frosts, heat waves or heavy rainfall can cancel the advantages of the increase in temperature. The indirect effects of global warming such as soil infertility, water scarcity, grain yield and quality and diffusion of pathogens may impair animal production in these systems more than the direct effects. Indeed, in these systems the animals can cope better with the direct effects of high temperature, i.e. heat stress, with the
help of diet, techniques of cooling or farm management. On the other hand the employment of techniques to adapt air temperature of barns to the thermo neutrality of the animals causes higher energy consumption and therefore, worsens global warming and increases general costs of animal production. Moreover industrialized systems produce more manure than can be used as fertilizer on nearby cropland resulting in soil accumulation of phosphorous, nitrogen and other pollutants. In any case at a World level, animal production has to increase in the next decades to satisfy the growing need. According to Cohen (2001) in the year 2050, the world population will reach 9.3 billion and more than 60% will live in towns.

It is estimated that by then, global meat consumption will be twice that of today. How can we make animal production equal animal consumption in the next decades? The challenge will be how to better balance either the increase in the number of stock or the productivity per head, at the same time improving the sustainability of the livestock sector. This is an important task as today the billion land animals which are reared and slaughtered, either directly or indirectly contribute to total human induced greenhouse gas by 18% and total CO\textsubscript{2} emission by 9%.

IMPACT OF CLIMATE CHANGE ON ANIMAL HEALTH:

The effects of climate change on the health of farm animals are both direct and indirect. Direct effects include temperature-related illness and death, and the morbidity of animals during extreme weather events. Indirect impacts follow more intricate pathways and include those deriving from the attempt of animals to adapt to thermal environment or from the influence of climate on microbial populations, distribution of vector-borne diseases, host resistance to infectious agents, feed and water shortages, or food-borne diseases. If exposure to high air temperature is prolonged, lower feed intake is followed by a decline in the secretion of calorigenic hormones (growth hormone, catecholamine’s and glucocorticoids in particular), in thermogenic processes of digestion and metabolism, and metabolic rate. Heat stress negatively impacts a variety of productive parameters including milk yield, growth, reproduction, and carcass traits. In addition, heat load increases healthcare costs and animals can succumb to severe thermal stress (especially lactating cows and sows).

Recently Baumgard et al. (2007) described lower glucose and lower NEFA in heat-stressed cows compared with pair-fed cows. In addition, these authors demonstrated that glucose disposal (rate of cellular glucose entry) was greater in heat-stressed compared to thermal neutral pair-fed cows, and heat-stressed cows had a much greater insulin response to a glucose challenge when compared to underfed cows. The consequence of the reduction of hepatic glucose synthesis, the alteration of glucose turnover and the increased glucose demand for energy need is the lower availability of glucose for mammary gland lactose synthesis. Since, lactose production is the primary osmoregulator and thus determinant of milk yield, reduction of glucose availability leads to the reduction of milk yield and may account the reduction of milk yield not explainable by the reduction of feed intake under hot conditions. As already reported above, global warming will also affect the biology and distribution of vector-borne infections. Wittmann et al. (2001) simulated an increase of temperature values by 2°C, and under these
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conditions, their model indicated the possibility of an extensive spread of *Culicoides imicola*, which represents the major vector of the bluetongue virus. Another mechanism through which climate change can impair livestock health is represented by the favourable effects that high temperatures and moisture have on growth of mycotoxin-producing fungi. At lower concentrations, mycotoxins reduce the growth rate of young animals, and some interfere with native mechanisms of resistance and impair immunologic responsiveness, making the animals more susceptible to infections. Studies have shown that some mycotoxins can alter lymphocyte function in domestic ruminants through alteration of DNA structure and function.

**IMPACT OF CLIMATE CHANGE ON REPRODUCTION:**

High environment temperatures may compromise reproductive efficiency of farm animals in both sexes and hence negatively affect milk, meat and egg production and the results of animal selection. Heat stress compromises oocyte growth in cows by altering progesterone, the secretion of luteinizing hormone and follicle-stimulating hormone and dynamics during the oestrus cycle (Ronchi et al., 2001). Heat stress during pregnancy slows down growth of the foetus and can increase foetal loss, although active mechanisms attenuate changes in foetal body temperature when mothers are thermally stressed. Semen concentration, number of spermatozoa and motile cells per ejaculate of bulls are lower in summer than in winter and spring. Pigs are very sensitive to hot conditions. This is mainly due to the low sweating capacity. Increase in air temperature has a tremendous effect on periparturient sows. Sows and gilts that experience high air temperature in the mating period manifest a delayed return to oestrus or an increase in the number of non-pregnant animals. Heat stress impairs embryonic development and affects reproductive efficiency until 5-6 weeks after exposure to hot conditions.

Exposure to elevated ambient temperature decreases fertility even in poultry, rabbits and horses. Male birds appear to contribute more than females to heat stress related infertility, and high temperatures have a greater impact on semen quality and fertility in those males with a better sperm quality index.

**IMPACT OF CLIMATE CHANGES ON ANIMAL PRODUCTION:**

Climate affects animal production in four ways:

(a) The impact of changes in livestock feed-grain availability and price
(b) Impacts on livestock pastures and forage crop production and quality
(c) Changes in the distribution of livestock diseases and pests and
(d) The direct effects of weather and extreme events on animal health, growth and reproduction (Smith et al., 1996).

A thermal environment is a major factor that can negatively affect milk production in dairy cows, especially in animals of high genetic merit. High air temperatures even affect goats, reducing milk yield and the content of milk components. Beef cattle are particularly vulnerable not only to extreme environmental conditions, but also rapid changes in these conditions. In
particular, fatter cattle (fat under the skin provides an insulation layer trapping heat inside the animal), cattle with a heavier hair coat (more insulation) and darker coated animals (black and dark red cattle) are very sensitive to heat. Heat stress reduces the reproductive performance of laying hens by interrupting egg production. This may be caused not only by a reduction in feed intake but also by a disruption of hormones responsible for ovulation and a decrease in responsiveness of granulosa cells to luteinizing hormone.

**IMPACT OF CLIMATE CHANGE ON LIVESTOCK PRODUCTION SYSTEMS:**

Predictions of the impact of climate change on agriculture and livestock production systems are more reliable on a large-scale basis than at Agricultural, Allied Sciences & Biotech for Sustainability of Agriculture, Nutrition & Food Security local levels. Principally the prediction is qualitative, rather than quantitative. Climate change and variability will affect land-use and land-cover differently in different parts of the world. Possible future impacts of climate change on livestock production systems will largely depend on interactions of multiple processes and components. The foreseeable impacts will be governed by exposure to climate hazards and will be dependent on two main types of vulnerability:

a) Biophysical vulnerability (Sensitivity of natural environment to hazards) and
b) Social vulnerability.

The increase of climatic variability will exert a strong influence on pastoral systems, even though they have developed the capability to cope and adapt to climate uncertainty. However, since pastoral systems are totally dependent on availability of natural resources, the increase of inter-annual and seasonal variation of forage availability will contribute to reduce the overall sustainability, both from a social–economic and from an ecological perspective. Climate changes can affect crop-livestock systems, such as dairy cow farming, beef cattle farming, dairy sheep and goat farming, mainly acting on forage availability and quality, animal health and productivity. Less productive and better thermo-tolerant dairy cows, could substitute highly selected cows, in many areas. We can predict that global warming could seriously damage either beef or milk production, especially in mixed rain-fed systems. Under global warming, water will be the main common weak point in all livestock systems. The phenomenon of water salination is spreading in many areas of the World. Other than salination, water may contain chemical contaminants, either organic or inorganic, high concentrations of heavy metals and biological contaminants. Animals exposed to hot environments drinking an amount of water 2-3 times more than those in thermo-neutral conditions can run many risks. Conclusions: Scientific research can help the livestock sector in the battle against climate change. All animal scientists must collaborate closely with colleagues of other disciplines, first with agronomists then, physicists, meteorologists, engineers, economists, etc. Research must continue developing new techniques of cooling systems such as thermo-isolation, concentrating more than in the past on techniques requiring low energy expenditure.
CONCLUSION

Climate change could affect animal production and well-being, especially because of increases in air temperature. However, the knowledge of animal responses to heat stress during the hot months in several areas of the world, as well as during extreme heat events, may be used to evaluate the impacts of global change. Some current practices to reduce heat stress in dairy cows, such as shades, sprinklers and ventilation will be suitable for adapting to future climates if the economics of heat stress management do not change radically. However, farmers are not quite aware about the impacts global warming can produce in their operation.

REFERENCES

Innovative Approach in Agriculture Farming

ABSTRACT
Most populations of the world depend on an agro-based economy for their livelihood where a very significant portion of the gross domestic product comes from agriculture. However, in most under developed countries, due to subsistence farming, low education levels and lack of proper and well developed technology in puts into agriculture, agricultural activities are not advanced, leading to production under optimum level and poor storage of the produce. A storage pest may be referred to any organism that infests and damages stored food, books and documents, fabrics, leather, carpets, and any other dried or preserved item that is not used shortly after it is delivered to a location, or moved regularly. Generally these pests include various micro-organisms like fungi and bacteria, arthropods such as insects and mites and rodents. Losses can occur at several stages of the crop cycle, including threshing, storage, transport, milling, wholesale and retail distribution. Losses caused by insects include not only the direct consumption of kernels but also include accumulations of frass, exuviae, webbing and insect cadavers. High levels of this insect detritus may result in grain that is unfit for human consumption. Insect induced changes in the storage environment may cause warm, moist ‘hotspots’ that are suitable for the development of storage fungi causing further losses. Direct insect feeding on food grains results in a number of qualitative changes such as chemical changes in grain content. The contamination of grains with moult skin and body parts also makes them more susceptible to the spread of pathogenic microorganisms. Various eco-friendly as well as chemical methods can be used to protect heavy losses in stored grains. These methods reduce or check the infestation and damage caused by the storage pests, which ultimately prolongs the storage life of grains.
Keywords: storage pests, food, grains, pest-management.

INTRODUCTION

Integrated pest management (IPM), also known as integrated pest control (IPC) is an approach that involves integration of all the practices for economic control of pests. IPM is a systemic approach to crop protection that uses increased information and improved decision making paradigms to reduce purchased inputs and improve economic, social and environmental conditions on the farm and in society. IPM is based on ecological principles and is compatible with a sustainable and environmentally benign agricultural system. These managment practices aim to suppress pest populations below the economic injury level (EIL). The UN's Food and Agriculture Organization defines IPM as "the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development
of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. Integrated pest management highlights the concept of growing a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. IPM allows for safer pest control.

The IPM approach can be applied to both agricultural and non-agricultural settings, such as the home, garden, and workplace. IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides. In contrast, organic food production applies many of the same concepts as IPM but limits the use of pesticides to those that are produced from natural sources, as opposed to synthetic chemicals. There are six basic components of IPM system to work saliently-

IPM is not a single pest control method but, rather, a series of pest management evaluations, decisions and controls. In practicing IPM, growers who are aware of the potential for pest infestation follow a four-tiered approach. The four steps include:

**SET ACTION THRESHOLDS**

Before taking any pest control action, IPM first sets an action threshold, a point at which pest populations or environmental conditions indicate that pest control action must be taken. Sighting a single pest does not always mean control is needed. The level at which pests will either become an economic threat is critical to guide future pest control decisions. The major theory of IPM is generally to control, not eradication. According to the concept of IPM generally holds that wiping out an entire pest population is often impossible, and the attempt can be expensive as well as very unsafe. The very first step of IPM programmes is to establish the acceptable pest levels, called action thresholds, and apply controls if those thresholds are crossed. These thresholds limits are specific to pest and site, meaning that it may be acceptable at one site to have a weed such as white clover, but not at another site. Allowing a pest population to survive at a reasonable threshold reduces selection pressure. This lowers the rate at which a pest develops resistance to a control, because if almost all pests are killed then those that have resistance will provide the genetic basis of the future population. Similarly, with the repeated use of a single kind of control methodologies will create more resistant pest populations to that class, whereas alternation among different classes of methods will helps preventing resistant pests.

**MONITORING**

Not all insects, weeds, and other living organisms require control. Many organisms are innocuous, and some are even beneficial. IPM programs work to monitor for pests and identify them accurately, so that appropriate control decisions can be made in conjunction with action thresholds. This monitoring and identification removes the possibility that pesticides will be used when they are not really needed or that the wrong kind of pesticide will be used. Monitoring of insect pests and their natural enemies is a fundamental tool in IPM for taking management
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decisions. Monitoring requires estimation of changes in insect distribution and their abundance, information about the insects, life history and the influence of important biotic (natural enemies). Regular observation is critically important. Observation is broken into inspection and identification. Visual inspection, insect and spore traps, and other methods are used to monitor pest levels. Record-keeping is essential, as is a thorough knowledge of target pest behaviour and reproductive cycles. Since insects are cold-blooded, their physical development is dependent on area temperatures. Many insects have had their development cycles modelled in terms of degree-days. The degree days of an environment determines the optimal time for a specific insect outbreak. Plant pathogens follow similar patterns of response to weather and season.

USING PREVENTIVE CULTURAL PRACTICES

The first and the major line of defence starts with the selection of varieties best for local growing conditions and maintaining healthy crops. As a first line of pest control, IPM programs work to manage the crop, lawn, or indoor space to prevent pests from becoming a threat. In an agricultural crop, this may mean using cultural methods, such as rotating between different crops, selecting pest-resistant varieties, and planting pest-free rootstock. These control methods can be very effective and cost-efficient and present little to no risk to people or the environment. Plant quarantine and 'cultural techniques' such as crop sanitation are next, e.g., removal of diseased plants, and cleaning pruning shears to prevent spread of infections. Also the addition of beneficial fungi and bacteria are added to the potting media of horticultural crops vulnerable to root diseases, greatly reducing the need for fungicides.

CONTROL

Once monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs then evaluate the proper control method both for effectiveness and risk. Effective, less risky pest controls are chosen first, including highly targeted chemicals, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding. If further monitoring, identifications and action thresholds indicate that less risky controls are not working, then additional pest control methods would be employed, such as targeted spraying of pesticides. Broadcast spraying of non-specific pesticides is a last resort.

Mechanical controls—should a pest reach an unacceptable level, mechanical methods are the first options. They include simple hand-picking, barriers, traps, vacuuming and tillage to disrupt breeding.

Biological controls —Natural biological processes and materials can provide control, with acceptable environmental impact, and often at lower cost. The main approach is to promote beneficial insects that eat or parasitize target pests. Biological insecticides, derived from naturally occurring microorganisms (e.g.—Bt, entomopathogenic fungi and entomopathogenic nematodes), also fall in this category. Further 'biology-based' or 'ecological' techniques are under evaluation.
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**Responsible use**—Synthetic pesticides are used as required and often only at specific times in a pest's life cycle. Many newer pesticides are derived from plants or naturally occurring substances (e.g.—nicotine, pyrethrum and insect juvenile hormone analogues), but the toxophore or active component may be altered to provide increased biological activity or stability. Applications of pesticides must reach their intended targets. Matching the application technique to the crop, the pest, and the pesticide is critical. The use of low-volume spray equipment reduces overall pesticide use and labour cost.

An IPM regime can be simple or sophisticated. Historically, the main focus of IPM programmes was on agricultural insect pests. Although originally developed for agricultural pest management, IPM programmes are now developed to encompass diseases, weeds and other pests that interfere with management objectives for sites such as residential and commercial structures, lawn and turf areas, and home and community gardens.

**INSECT PESTS OF STORED GRAINS**

**INTRODUCTION**

Losses of grain in storage due to insects are the final components of the struggle to limit insect losses in agricultural production. The above said losses can exceed those incurred while growing the crop. A loss caused by insect pests not only includes the direct consumption of seeds/kernels, but also include accumulations of frass, exuviae, webbing, and insect cadavers. A very large scale infestation by insect pests may result in heavy economic losses as well as a grain that is unfit for human consumption. Insect-induced changes in the storage environment may cause warm, moist ‘hotspots’ that are suitable for the development of storage fungi that cause further losses.

A limited insect infestation in grain storage must be a primary consideration beginning at the time of harvest. In an economic manner, storage insects and, to a lesser degree, fungi reduce the quality and value of grain, while losses due to rodents and birds are typically less frequent and very minor. Infestation on-farm may further proliferate to devastating losses throughout the grain storage and marketing ecosystem. It is essential that on-farm storage should limit the infestation of grain from the onset of storage, to ensure the acceptance and marketability of grain in domestic and foreign channels. There are a number of procedures to manage the pests are used to prevent infestation before storage, a few that minimize the pest invasion into storage includes the following:

- Cleaning of bins, harvest and loading equipment prior to harvest and after bin emptying,
- Application of “empty-bin” insecticides to the inside of the structures,
- Sealing structures,
- Cleaning up grain spills on the grounds,
- Removing weeds close to structures,
- Stored Grain Insects

In addition to obvious identifying characteristics, the feeding habits of storage insect pests are used to separate them into two classes: Primary pests and secondary invaders.
Primary pests are those that are capable of penetrating and infesting intact kernels of grain, and have immature stages that can readily develop within a kernel of grain. While the Secondary invaders are unable to infest the grains but feed on broken kernels, debris, higher moisture weed seeds, and grain damaged by primary insect pests.

In general, the immature stages of these species are found external to the grain. It is often thought that secondary invaders cannot initiate an infestation. This is untrue as in almost any storage situation there will be adequate amounts of broken grains and debris to support an infestation by secondary invaders. Moreover, secondary invaders contribute directly to grain spoilage after establishment, just as primary pests do. However, the most damaging insect types are those that feed within the kernel itself, causing insect-damaged-kernels (IDK). Wheat is discounted based on the number of insect-damaged-kernels (IDK) as well as the presence of live insects, and other grain quality factors, when samples are graded at the time of sale.

Before applying any treatment, it is a good practice to have pests positively identified by an expert. But with magnification, a little practice, and a good reference guide, it is possible to identify most stored product insects.

CRITICAL IPM ISSUES

The integrated pest management (IPM) approach for protecting stored grain includes:

- Sanitation
- Frequent monitoring
- Aeration
- Biological control
- Pesticide treatments

IPM techniques should be considered as tools in a toolbox; not all of them are needed every time, such as pesticides, but still need to be available.

SANITATION AND GRAIN LEVELING

The key aspect for preventing insect infestations is to continually clean and properly maintain the storage structure. Stored grain insects breed readily in residual grain. They also live and feed on cracked grain, grain trash, or left over grain from previous crop. Both birds and rodents are also attracted to spilled grain. Rodents and pest insects find harbourage and food in mature weeds surrounding the facility. The following are standard sanitation practices used for empty storage facilities.

- Clean harvest and transportation equipment before the harvest.
- Storage structures are emptied of old grain. Never store a new crop on top of old grain.
- Floors and walls inside empty bins are swept of old grain and debris.
- Weeds around the bins are removed.
- Remove spilled grain outside the storage structure.
- All grain handling equipment is repaired and kept in good condition before harvest.
For additional protection, the inside and outside surfaces, foundations and floor of a storage facility should be treated with a residual insecticide, four to six weeks prior to harvest. This will kill any insects that were not removed during cleaning and those that migrate into the bin. Improper storage results in moisture wicking up the peaked grain and accumulating in the grain mass in this peak. Storage fungi can readily establish in this area, leading to spoilage, the development of hot-spots, and providing a very favourable environment for a large population of storage insects. The process of levelling the grain requires the judicious use of the grain auger and a brief period of physical labour using a grain shovel. The level surface is well suited for monitoring with pitfall traps, and for the proper application of fumigants.

**MONITORING**

Pest monitoring is an important component in the IPM post-harvest practice for stored grain. Inspections should be done frequently, especially after first storage. Initially, grain is inspected for insects weekly until the baseline insect numbers are known. Then the grain is monitored every 2-3 weeks during throughout the autumn until the grain is cooled to 50-55°F or below, and monitored monthly for the remainder of the storage period.

The following points must be monitored carefully by the grain managers-

- Grain quality
- Grain temperature
- Insects and insect density
- Hot spots
- Mould growth
- Any “off odour”

Temperatures below 60°F prevent insect activities, while higher temperatures allow for increased insect growth and breeding. Many storage structures are equipped with temperature sensors that provide the temperature of the grain through the grain mass. The sensors are placed on permanent cables that are suspended from the roof of the storage bin. Three are midway between the centre and the wall, and one is very near the centre.

Information is transmitted for each thermocouple to a reading device that helps grain managers record temperature over time. More than a five-degree rise (>50 F) recorded by one of the thermocouples over a two-week period indicates a pest or moisture problem exists in that location. Monitoring also detects changes in grain temperature during aeration or seasonal temperature fluctuations. Temperature of the stored grain in bins without temperature monitoring devices can be monitored by a thermometer mounted on a probe and inserted into the grain mass, or simply by inserting one’s arm into the top layer of the grain mass. Frequent grain sampling from several locations throughout the storage structure provides grain managers with the status of insects and grain quality. Initial sampling should be done at least weekly until the history of the grain has been clarified. In many warmer locations, samples are collected from standing grain using either a deep bin cup or a grain trier.
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An alternative that works quite well is to use pitfall probe traps that remain in the grain. These traps are placed just below the grain surface or probed into the grain. With Montana’s, comparatively low insect numbers, these traps can be serviced weekly to readily provide similar information to sampling. Note that the traps are more sensitive than sampling, so the numbers will appear greater than from sampling.

Nonetheless, the basic approach remains the same. Numbers and species of insects are recorded to assess a monthly pattern. The presence of insects in dry whole grain is an indication of future economic loss (in terms of live insects at time of sale). The presence of IDK-causing insects will result in discounts at the time of sale. A mouldy appearance, dampness, off-odour, presence of IDK, and high moisture levels can also indicate insect problems. Consistent findings of internal feeders and IDK call for fumigation to protect grain value.

AERATION

Aeration is used to dry and cool newly-stored grain. It is also used to prevent moisture migration when ambient temperatures drop below that of the grain temperature. Moisture migration occurs when outdoor temperatures decline during the fall and winter. Grain and air temperatures near the bin walls also drop. The insulating characteristics of grain prevent temperature changes in the centre of the grain mass from falling as rapidly. Cooling air near the bin wall makes this air denser (heavier), and it settles toward the bin floor. At the same time, warmer air near the centre of the bin floor is less dense (lighter). This air, which is displaced by the cooler air, rises through the centre of the bin, absorbing small amounts of moisture from the surrounding grain as it rises. Grain near the top of the grain mass, like that near the outer walls, is cooler than the rising air. As the warm air rises through the cooler grain and is cooled by it, moisture condenses from the air onto the grain. This moisture migration produces wetting and crusting of surface grain.

Prevention of moisture migration by maintaining a uniform temperature throughout the grain mass greatly reduces the possibility of mould development as well as insect feeding and reproduction. Aeration will not kill insects, but will slow their growth and development. Aerated bins contain lower insect populations than non-aerated bins through the winter, thus aeration greatly reduces the requirement for fumigation. In Montana, running aeration fans continuously for up to one week, and then running them only at night will rapidly cool grain stored to temperatures that inhibit insect feeding and reproduction in smaller bins.

BIOLOGICAL CONTROL

There are a number of insect predators and parasitic wasps that attack insect pests of stored grain. All are effective if used in overwhelming numbers. However, biological are generally not used because the Food and Drug Administration (FDA) and food processors do not accept live insects or insect parts in raw grain. This inductive approach is simply the addition of very large numbers of beneficial insects. Biological agents have limited commercial availability and are cost prohibitive, except perhaps for organic production. Specific species that attack the
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different groups of pests are listed below. It is important to note that there are limited numbers of naturally occurring biological control agents:

**INSECTICIDE TREATMENTS**

Empty bin treatments include residual insecticides applied in and around the fan, aeration ducts, auger, door openings, and hatch covers, or fumigants, before bins are filled at harvest. Commercial facilities must comply with the Occupational Safety and Health Administration (OSHA) bin entry permits. Following are pesticides available for treating empty bins:

Grain protectants are insecticides applied directly onto grain going into the storage or already in storage. Grain protectants do not kill insects inside the kernels. Following are insecticides labeled as protectants.

In Montana, the use of protectants should be limited to high-value commodities that need protection during storage for several months, and for which it is cost effective to use them. For direct application on wheat at first storage, there are limited circumstances where the use of a protectant is necessary.

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>Example Brands</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorpyrifos-methyl</td>
<td>Reldan 4E®</td>
<td>Reldan does not control lesser grain borer. Can only be applied to the grain stream as it is moved (augered) into the bin. Use limited to existing stocks.</td>
</tr>
<tr>
<td>Malathion</td>
<td>Malathion 5EC</td>
<td>Existing stocks are available but label has been withdrawn. Most stored grain insects are resistant.</td>
</tr>
<tr>
<td>Methoprene</td>
<td>Gentrol, Diacon II®</td>
<td>Kills developing insects only, slow kill of larvae, no kill of adults though causes sterility. High cost and must use other products before sale. Newly marketed.</td>
</tr>
<tr>
<td>Chlorpyrifos-methyl + cyfluthrin</td>
<td>Storcide®</td>
<td>Can only be applied to the grain stream as it is moved (augered) into the bin. It is not recommended for grain intended for export.</td>
</tr>
<tr>
<td>Pyrethrins</td>
<td>Pyrenone®</td>
<td>Expensive, short residual life.</td>
</tr>
<tr>
<td>DVP</td>
<td>Vapona®</td>
<td>Also as strips. Used in the head space against Indian meal moth.</td>
</tr>
</tbody>
</table>
### Dust Insecticides Labelled for Use as Grain Protectants

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>Malathion</td>
<td>Big 6 Grain Protector®, Agrisolutions 6% Malathion Grain Dust</td>
<td>Top-dress treatment. Insects are resistant in many areas. Millers resist purchasing grain with strong malathion odour.</td>
</tr>
<tr>
<td>Diatomaceous earth (DE)</td>
<td>Protect-Itä, Insecto®</td>
<td>Can lower the test weight of grain and is expensive if it is applied to entire grain mass, so is best applied to empty bins and to the top and bottom layers of the grain mass.</td>
</tr>
</tbody>
</table>

### FUMIGANTS

Properly conducted fumigation will stop insect infestation and grain degradation from getting progressively worse. When fumigation is effectively conducted in late fall, pest populations can be drastically reduced.

Fumigation is recommended if:

- ✔ Grain samples reveal the presence of insect-damaged-kernels (IDK).
- ✔ Samples or traps capture harmful insects (lesser grain borer, granary weevil).
- ✔ Trapping or sampling indicates that a population of secondary pests like the rusty grain beetle is expanding rapidly.

Fumigants registered for use are phosphine, either released from aluminum or magnesium phosphide or directly as a gas, methyl bromide, and chloro-picrin (used for empty bin treatment only). Tablets or pellets of aluminum or magnesium phosphide are sold under Weevilcide®, Fumitoxin®, and Phos-toxin® trade names. Phosphine gas mixed with carbon dioxide is sold in gas cylinders as ECO2-Fume®. Methyl bromide is expensive, difficult to use properly on raw grain, kills the germ, and is not recommended for stored grain, especially seed wheat. In addition, methyl bromide use is being phased out due to its status as an ozone deplete under the Montreal protocol.
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The phosphide pellets or tablets release phosphine gas as they are exposed to moisture in the air. In a large storage facility, phosphide pellets or tablets are often added to infested grain as it is moved from one silo to another silo, bin, railcar, or truck.

Fumigation is more effective when sanitation, grain leveling, removal of fines, and thorough bin sealing has been done in advance. It is essential that the level of phosphine remain adequate (greater than 200 ppm) for as long as possible, with a minimum of 100 hours recommended to kill all life stages of the pest insects at optimal temperatures. Many of the regulations stressed in this manual were recently established. The label and applicators manual are considered part of the revised label, and the label requirements are far more stringent than for the previous label and include:

- a stricter restricted use statement requiring the physical presence of a certified applicator when the product is used,
- a requirement that two trained applicators be present whenever fumigation or gas monitoring requires work or re-entry within confined spaces which reinforces the common sense approach that fumigators should always work in pairs,
- Language that fumigant use must be in strict accordance with the label.
- In addition, certified applicators must:
- Ensure that the fumigated facility is secure and pleaded before leaving.
- be physically present and responsible for all workers when the fumigation exposure is complete,
- Ensure that the structure is opened for aeration.

The certified applicator is also responsible for the monitoring of exposure levels during the application, fumigation, and aeration process. For this reason, the new label has strict sealing guidelines to prevent exposure to phosphine gas escaping from leaky storage structures. The new label also sets on maximum dosage levels and gives recommended dosage ranges for specific applications, whereas the preceding label only set minimum and maximum dosage levels. Also, the entire label must be physically present when the product is used, and if an incident with adverse effects on human health or the environment occurs, the product registrant must be informed.

There are also requirements for weatherproof pleading, with name of the applicator and the product EPA registration number affixed.

There are requirements for the reporting of product theft to local police, and for DOT transportation labels when the product is transported.
ORGANIC FARMING: NEED AND SCOPE
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ABSTRACT
The population of the planet is skyrocketing and providing food for the world is becoming extremely difficult. The need of the hour is sustainable cultivation and production of food for all. The Green Revolution and its chemical based technology are losing its appeal as dividends are falling and returns are unsustainable. Pollution and climate change are other negative externalities caused by use of fossil fuel based chemicals. Organic farming is preferred as it involves less input costs for cultivation and preserves the ecological balance while promoting biological diversity and protection of the environment. Organic farming is a farming method which involves growing and nurturing crops without the use of synthetic based fertilizers and pesticides and also no genetically modified organisms are permitted. This is a farming method that works at grass root level preserving the reproductive and regenerative capacity of the soil, good plant nutrition and soil management that produces nutritious food rich in vitality which has resistance to diseases. Total area under organic certification process (registered under National Programme for Organic Production) is 3.56 million Hectare (2017-18). This includes 1.78 million ha (50%) cultivable area and another 1.78 million Hectare (50%) for wild harvest collection. Among all the states, Madhya Pradesh has covered largest area under organic certification followed by Rajasthan, Maharashtra and Uttar Pradesh. Organic farming relies on ecologically balanced agricultural principles like crop rotation, green manure, organic waste, biological pest control, mineral and rock additives. Organic farming enhances the nutrients of the soil which is passed on to the plants and animals and use natural farming techniques that don’t harm humans and environment. These foods keep dangerous diseases like cancer and diabetes at bay. Organic farming does not make use of poisonous chemicals, pesticides and weedicides. It care for the larger environment and conservation of natural habitats and wildlife.

Keywords: Future Prospective, Natural farming, Organic Farming,

INTRODUCTION
In India, Organic Farming is the ancient way of farming which is being followed since ages to gain sustainable crop production. Organic Farming emphasizes on using only biological materials and bio-fertilizers to provide nutrients for the growth of the crops and that too in pollution free and Eco-friendly environment. Organic Farming is the natural way of farming in which no chemicals are used either as fertilizers, or pesticides. Organic Farming is done using only natural manures like organic wastes, farm wastes, animal wastes, compost, etc. It basically aims at keeping the soil alive with maintaining the health of soil (Meena et al, 2003). Crop rotation, mixed cropping and biological pest control are some of the methods being followed in Organic Farming. Total area under organic certification process (registered under National Programme for Organic Production) is 3.56 million Hectare (2017-18). This includes 1.78 million ha (50%) cultivable area and another 1.78 million Hectare (50%) for wild harvest collection. Among all the states, Madhya Pradesh has covered largest area under organic certification followed by Rajasthan, Maharashtra and Uttar Pradesh.
NEED AND SCOPE OF ORGANIC FARMING

Organic farming is an important way of maintaining the natural habitat. Through organic farming the environment remains pure and less polluted and all the sources to maintain life on this planet remain less threatened. The population of the planet is skyrocketing and providing food for the world is becoming extremely difficult. The need of the hour is sustainable cultivation and production of food for all. The Green Revolution and its chemical based technology are losing its appeal as dividends are falling and returns are unsustainable. Moreover, organic farming is imported to provide healthy food to the people. When they consume the produce of organic farming in the form of healthier food very less or no chemical enter in their body through food and hence they become less prone to deadly diseases. Also, the soil remains in better condition and excessively fertile because of the natural manures used in organic farming. Important features of Indian organic sector with the phenomenal growth in area under organic management and growing demand for wild harvest products India has emerged as the single largest country with highest arable cultivated land under organic management. India has also achieved the status of single largest country in terms of total area under certified organic wild harvest collection.

TYPES OF ORGANIC FARMING

1. Integrated Way of Organic Farming
   Integrated Organic Farming is followed largely across the country. According to this method, the crops maintain their complete nutritive value by integrating all the required nutrients from natural resources. Simultaneously it help in preventing the plants from getting damaged from pests but in a natural way. Over the year successive governments have launched farmers’ awareness drive to educate and train farmers in new scientific developments to increase crop production by integrated way of organic farming. Consequently, integrated organic farming has become overly popular resulting in improvement of crop yield in even the hilly regions like North-Eastern states. Meghalaya is a shining example of improvement in agriculture through integrated organic farming. Moreover, concerted efforts are being made through progressive research towards improving the integrated farming in different agriculture Institutes in India and resulted into widespread use of the integrated farming methods like crop rotation, double and triple cropping systems, the farmers are able to increase their income over the years through integrated way of organic farming.

2. Pure form of Organic Farming
   Pure form of organic farming is a farming method in which the farmers use only organic manures and pesticides. The pesticides used in this type of farming also remain chemical free and are made only through natural substances like Neem, etc. In other words we can say that pure form of organic farming is done with complete avoidance of any kind of inorganic chemicals as fertilizers as well as chemical pesticides.
3. **Integration of different farming systems**

Integration of different farming systems involves several other components of farming such as poultry, mushroom production, goat rearing, and fishpond simultaneously with regular crop components.

**METHODS OF ORGANIC FARMING**

1. **Management of Soil**: Soil management is the soul of organic farming. It is a well-known fact that after taking one crop, the soil of the farm loses most of its nutrients and also its fertility. The process of recharging the soil with all the necessary nutrients is called soil management. In organic farming the nutrients are recharged in the soil through natural ways to increase the soil fertility. For this purpose, animal waste is increasingly used to recharge the soil with the necessary nutrients. The bacteria present in animal waste make soil fertile once again.

2. **Management of Weeds**: Organic farming focuses on removing the weeds from the soil during the crop production. Weeds are unwanted plants that grow in the agriculture fields simultaneously with the crops and they use most of the nutrients present in the soil. As a result the production of the crops gets affected. To get rid of weeds the farmers follow the techniques like:

   **Mulching and Cutting or Mowing**: Mulching is a process in which the farmers use plant residue or plastic films on the surface of the soil which blocks the growth of the weed while cutting or mowing helps in removal of the growth of the weeds in the farms.

3. **Crop diversity**: Crop diversity is one of the most important methods of Organic Farming and there are two practices followed for this are Monoculture and Polyculture. In monoculture way of organic farming, the farmers take only one crop at a time while in Polyculture method, the farmers harvest different kinds of crops in one field and get leveraged by increase in production of different crops from one field. Polyculture way of organic farming also helps in producing microorganisms in soil to make it excessively fertile.

4. **Controlling the harmful organisms**: Organic farming lays much emphasis on controlling the harmful organisms present in the agricultural farms which negatively affect the crop production capacity of the fields. For this purpose the farmers use pesticides and herbicides, however in organic farming only natural pesticides are used.

5. **Use of green manure**: Farmers use the dying, or uprooted plants as green manure in Organic farming. These plants are turned into the soil through tilling to decay further and form nutrient for the soil to increase its fertility.

6. **Use of compost**: The farmers prepare compost by digging a pit and filling green waste and water in it to decay. Later this compost which is highly rich in nutrients for crops is used as fertilizer in the farms to increase the soil fertility.
PRINCIPLES OF ORGANIC FARMING

Principle of health

This principle points out that the health of individuals and communities that cannot be separated from the health of ecosystems - healthy soils produce healthy crops that promote the health of animals and people. Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health. The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. For that, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being and it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

Principle of ecology

This principle roots organic agriculture within living ecological systems. It states that the production is to be based on ecological processes and recycling. Nourishment and well-being are achieved through the ecology of environment. For example, in the case of crops this is the living soil; for animals it is the farm ecosystem; for fish and marine organisms it is the aquatic environment. Organic farming, pastoral and wild harvest systems should fit in the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality such that resources will be conserved. Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade or consume organic products should protect and benefit the common environment like landscapes, climate, habitats, biodiversity, air and water.

Principle of fairness

Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings. This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties – farmers, workers, processors, distributors, traders and consumers. Organic agriculture should provide a good quality of life, and contribute to food sovereignty and reduction of poverty to everyone which are involved. It aims to produce a sufficient supply of good quality food and other products. This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and well-being. Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs.

Principle of care
Innovative Approach in Agriculture Farming

Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of health and well-being. Consequently, new technologies need to be assessed and existing methods should be reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken. This principle states that precaution and responsibilities are the key concerns in management, development and technology choices in organic agriculture. Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes.

ADVANTAGES OF ORGANIC FARMING

1. **Regenerating the degraded soil**: Organic farming is the best way to prevent environmental pollution as well as degradation of soil. In some areas of the world where the soil has been degraded due to excessive use of chemical fertilizers, organic farming is helping in regenerating the soil by recharging it with necessary nutrients.

2. **Maintaining the optimal condition of soil**: Since only Organic manures are used in organic farming it helps in maintaining the optimal condition of soil to gain higher production of good quality of crops.

3. **No need to purchase chemical manures**: The farmers use only natural and organic manures in organic farming so the farmers are not required to purchase any chemical manures which reduces the expenses of the farmers considerably.

4. **Improves soil quality**: Organic farming helps the soil to regain its fertility power, since this kind of farming supplies various necessary nutrients in the soil and moreover it helps the soil in retaining its nutrients.

DISADVANTAGES OF ORGANIC FARMING

1. **Higher production costs**: For organic farming the farmers require more manpower to maintain various works associated with it which increases the crop production costs.

2. **Crops yield become more expansive**: Since the farmers do not get much yield from their farms through organic farming in comparison to the conventional farming their produce becomes more expansive.

3. **Nutrient leaching**: Excess nutrients in lakes, rivers, and groundwater can cause algal blooms, eutrophication, and subsequent dead zones. In addition, nitrates are harmful to aquatic organisms by themselves (Tilman et al, 2006).

4. **Land use**: Studies found that organic farming requires 84% more land for an equivalent amount of harvest, mainly due to lack of nutrients but sometimes due to weeds, diseases or pests, lower

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yielding animals and land required for fertility building crops (Tuomisto et al, 2012). While organic farming does not necessarily save land for wildlife habitats and forestry in all cases (University of Oxford, 2012), the most modern breakthroughs in organic are addressing these issues with success (Rodale Institute, 2014).

CONCLUSION

If we take long term perspective, organic farming is necessary to sustain life on the mother earth. Organic farming is necessary to recharge the soil’s fertility in a natural way and to produce healthy food for the people. Even though the farmers can be impacted by low crop yield, organic farming is necessary for all to lead the life in a natural way with maintaining ecological and environmental balance for the future generations. Looking at the current scenario when the soil in our agriculture fields are getting deteriorated due to excessive use of chemical fertilizers, Organic farming can be the best way to recharge the Mother Earth with all the natural nutrients so that human population may lead more healthier life.

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INTRODUCTION

The emergence of India as a leading dairy nation of the world could be attributed mainly to the intensive growth in milk production. The importance of dairy enterprise in the national economy can be gauged from the fact that the value of output from milk group is highest among all the agricultural commodities, accounting for nearly one fourth of the value of output from agricultural sector. Dairying is one of the most important means of providing livelihood and nutritional security to the rural masses. Empirical evidences indicate that livestock is an important component of the agriculture system, providing an additional source of income and nutritional cover to a large section of the rural population, particularly the disadvantaged and poor households (Rao et al 2003; Birthal and Ali 2005; Ravikumar and Chander 2006, Singh et al 2007). The use of Information and Communications Technology (ICT) has revolutionized manufacturing and services the world over. In the developing countries, the use of ICT has become vital to improve productivity in dairy production especially through its application in clean milk production and dairy processing. It is of developing effective information systems for planning and monitoring dairy development programmes, improving dairy services and enabling learning for capacity development that use ICT effectively and efficiently. India will need to apply new ICTs effectively in improving these systems so that they support meeting each of the above requirements for its dairy sector.

CONCEPT

A. Information technology (IT) is the term used to describe the items of equipment (hardware) and computer programs (software) that allow us to access, retrieve, store, organise, manipulate, and present information by electronic means. “The term information technology embodies a convergence of interest between electronics, computing and communications, all of which are leading to the rapid development of micro electronics” (Drew and foster, 1994).
B. Communication technology (CT) is the term used to describe telecommunications equipment through which information can be sought and accessed, for example, phones, faxes, modems, and computers.

C. Information and Communications Technology (ICT) Collectively refers to the technologies, both hardware and software, that enable humans to communicate with one another. “ICT includes electronic networks - embodying complex hardware and software – linked by the vast array of technical protocols” (Mansell and silverstone, 1996).

ICT APPLICATION

A. E-government

Implementation of e-government strategies focusing on promotion of transparency in public administrations and democratic processes, improving efficiency and strengthening relations with citizens.

B. E-learning

Developing domestic policies to ensure that ICTs are fully integrated in education and training at all levels, including in curriculum development, teacher training, institutional administration and management, and in support of the concept of lifelong learning.

C. E-agriculture

Ensuring the systematic dissemination of information using ICTs on agriculture, animal husbandry, fisheries, forestry and food, in order to provide ready access to comprehensive, up-to-date and detailed knowledge and information, particularly in rural areas.

POTENTIAL IT TOOLS FOR TRANSFER OF TECHNOLOGY IN AGRICULTURE & DAIRYING

A. RADIO

Radio is the oldest IT tool and provides entertainment to masses to a great extent in recent past. All India Radio presently has 208 radio stations and 327 transmitters. Through Farm and Home program, AIR is broadcasting agriculture programme in general covering 60-100 minutes per day on an average.

B. TELEVISION

Undoubtedly, television is the most powerful media close to the rural masses. In transfer of technology process, TV plays an important role especially at the awareness and interest stage of adoption. Message through it can motivate, stimulate, induce and change attitude of the farmers.
C. TELEPHONE

Telephone has also established itself in the rural areas and is becoming quite popular both with farmers and farmwomen. The union cabinet has approved the floated plan for the call centers meant for the farmers. The call centers are known by the name “Kisan Call Centers” and answer queries in local languages. The call centers are in operation since 21st of January 2004. It is being operated through toll-free telephones bearing the number 1551 from eight selected locations covering all states and regional languages.

D. VIDEO

Video is another IT tool for generating and promoting interaction. Experiments with small format videotape have recently aroused the interest of farmers in developing countries. Videotapes are seen as an ideal medium to promote motivation, attitudinal change, behavior reinforcement, community participation and entertainment. Videotapes have tremendous utility in the training of extension personnel.

1. Various ICT initiatives by National Dairy Research Institute (NDRI) for Dairy Extension Services

National Dairy Research Institute has developed information packages in the form of video films and multimedia packages on clean milk production, hygienic milk processing, packaging and scientific calf rearing etc. based on Information and Communication Techniques (ICT). Mechanisms for transforming the output of R&D efforts into viable technologies are being further strengthened by establishing National Demonstration Centers.

Table: 1. Various ICT initiatives by National Dairy Research Institute (NDRI) for Dairy Extension Services

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>Language</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>Video film produced</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Clean Milk Production</td>
<td>Hindi and English</td>
</tr>
<tr>
<td>2</td>
<td>Hygienic milk and milk product processing and packaging</td>
<td>Hindi and English</td>
</tr>
<tr>
<td>3</td>
<td>Scientific calf rearing practices</td>
<td>English</td>
</tr>
<tr>
<td>4</td>
<td>Success Story of a Dairy Entrepreneur</td>
<td>Hindi and English</td>
</tr>
<tr>
<td>5</td>
<td>Success Story of women SHG (Anmol Mahila Dugdh Samitee)</td>
<td>Hindi and English</td>
</tr>
<tr>
<td></td>
<td><strong>Multimedia Package</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>e-Book on Clean Milk Production</td>
<td>English</td>
</tr>
<tr>
<td>2</td>
<td>Multimedia on Clean Milk Production</td>
<td>Hindi and English</td>
</tr>
<tr>
<td>3</td>
<td>Interactive web module for dairy innovations</td>
<td>Hindi and English</td>
</tr>
</tbody>
</table>
1. Various ICT initiatives by Indian Veterinary Research Institute (IVRI) in Dairy Extension Services

Indian Veterinary Research Institute is a premier institute in the field of livestock management, health and disease diagnosis. It has developed several ICTs related to dairying in the form of video films, educational softwares (PAKRSP and LPDIS), Audio Visual Aids, search engine and android apps.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video film produced</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>A short film on neonatal calf management</td>
<td>Hindi and English</td>
</tr>
<tr>
<td>2</td>
<td>A short film on clean milk production</td>
<td>Hindi and English</td>
</tr>
<tr>
<td>Educational software</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>“Pashudhan Evan Kukkut Rog Suchana Pranali” (PAKRSP) for farmers</td>
<td>Hindi</td>
</tr>
<tr>
<td>5</td>
<td>Livestock and poultry disease information system (LPDIS) for students and professionals</td>
<td>English</td>
</tr>
<tr>
<td>Audio-Visual aids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Health information system for dairy animals (video CD)</td>
<td>Marathi</td>
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<tr>
<td></td>
<td>Livestock disease and neonatal calf disease (Audio CD)</td>
<td>-</td>
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<tr>
<td>Search Engine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Digital pashu swasthya and pshupalan prashnottari</td>
<td>Hindi</td>
</tr>
<tr>
<td>Android apps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>IVRI dairy manager</td>
<td>English</td>
</tr>
<tr>
<td>2</td>
<td>IVRI Pashu prajnan</td>
<td>English, Hindi and others</td>
</tr>
<tr>
<td>3</td>
<td>IVRI Artificial insemination</td>
<td>English</td>
</tr>
<tr>
<td>4</td>
<td>Organic Livestock Farming</td>
<td>English</td>
</tr>
</tbody>
</table>
### Table: 2. E-Governance Initiatives – India

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>ICT</th>
<th>Initiator</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| 1       | Dairy Information Services Kiosk | IIM, Ahmadabad                        | ➢ Its target for the booming dairy sector  
➢ It is a automatic milk collection center |
| 2       | mKisan                     | Govt. of India                         | ➢ It is a mobile based information technology  
➢ Provide actionable information on crops, livestock, market prices and weather based advisories |
| 3       | AKASHGANGA “The Milky Way” | Shree Kamdhenu Electronics Pvt. Ltd.   | ➢ Automatic milk collection system  
➢ It is a user-friendly, simple tools for dairy industry |
| 4       | Milk “ATM”                 | AMUL Dairy                             | ➢ ATM (Any Time Milk)  
➢ It is a milk vending machines |
| 5       | Dairy knowledge Portal     | NDDB                                   | ➢ provide an interactive dairy information and education channel to the farmers |
| 6       | Massaging Portal           | KVK Pratapgarh                        | ➢ provide information on different dairy farming practices |

### Table: 3. E-Governance Initiative- World

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>ICT</th>
<th>Country</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| 1       | Fencepost | New Zealand | ➢ It is a website called fencepost.com  
➢ It is a unique community & business channel  
➢ Its provide personal output information, market and commodity updates, free weather updates, industry-related news, expert advice, discussion groups, sporting news and email as well as special deals on farm goods |
| 2       | e-dairy | Sri Lanka | ➢ It is a mobile based information technology  
➢ Its aim is to achieve self sufficiency in milk production  
➢ It is a user-friendly technology |
| 3       | i-COW | Kenya     | ➢ SMS based information and education platform  
➢ The service aims at helping small scale farmers increase their productivity by giving them access to pivotal information  
➢ It consists of three flagship features  
1. Mashauri is the educational feature  
2. Kalenda is a gestation calendar  
3. Vetenari enables farmers to access 24/7 a database of registered vet's and AI's. |
CONCLUSION

Thus, the role of Information communication Technology to develop dairy and quality of life in rural area is well established. ICT can help an average Indian farmer to get relevant information regarding dairy-inputs, livestock production technologies, dairy processing, market support, finance and management of farm business. The agricultural extension mechanism is becoming dependent on ICT to provide appropriate and location specific technologies for the farmers. To furnish timely and proficient advice to the farmers, ICT can be a best mean not only to develop agricultural extension but also to expand agriculture research and education system.

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INTRODUCTION
Irrigation - Irrigation is the artificial application of water to the land or soil. It is used to assist in the growing of crops. Irrigation is necessary in arid areas or during a period of inadequate rainfall. Basically irrigation is used to improve food security, reduce dependence on monsoon, improve agricultural productivity, create rural job opportunities, to leach or dilute salts in soil, helps in cooling the soil and atmosphere to create more favorable environment for crop growth, dams used for irrigation projects help produce electricity & transport facilities as well as provide drinking water supplies to a growing population, control floods & prevent droughts and optimum use of water. Sources of Irrigation in India - major & minor canal from Indian rivers, groundwater well based systems, tanks and rainwater harvesting.

Note: 2/3rd cultivated land in India is depends on monsoons.
Innovative Approach in Agriculture Farming

Efficient irrigation results in increased crop yield, soil fertility and water utilized economically. Over irrigation however results in leaching of fertilizer, waterlogging and salt accumulation.

In irrigation method, system is designed to apply the right amount of water at the right time and apply it uniformly to raise the level of soil moisture in the crop root zone to its field capacity.

**Some Older Irrigation Methods:**

(a) Persian Wheel  
(b) Pulley System

(c) Bullock Drawn Well Irrigation  
(d) Chain Pump

Fig. 1 Older Irrigation Methods

**Selection of Method** - The suitability of the various irrigation methods, i.e. surface, sprinkler or drip irrigation depends mainly on the following factors such as natural conditions, type of crop, type of technology, previous experience with irrigation, required labor inputs, costs and benefits.

**Free flooding** – this method does not follow any design. Water is directly applied to the field.

**Basin Irrigation**- Basin irrigation is the most common form of surface irrigation, particularly in region with layout of small fields. If a field is level in all directions, is encompassed by a dyke to prevent runoff, and provides an undirected flow of water onto the field, it is called a Basin. A Basin is typically square in shape but exists in all sorts of irregular and rectangular configurations. Paddy rice grows best when its root is submerged in water and so basin irrigation is the best method to use for this crop. Not suited to crops which cannot stand in wet or waterlogged conditions for periods longer than 24 hours. Ex. Potatoes, beet, carrots etc. Good for loamy soil & flatter field.
Border Irrigation - Border irrigation can be viewed as an extension of basin irrigation to sloping, long rectangular or contoured field shapes, with free draining conditions at the lower end.

Furrow Irrigation - Furrow irrigation avoids flooding the entire field surface by channeling the flow along the primary direction of the field using furrows.

Sprinkler Irrigation - Water is piped through different locations in the field and is then distributed by high pressure sprinklers or guns. Sprinklers are mostly installed on permanent risers. Some sprinklers which rotate are called rotors. It is consists of a network of pipes & sprinklers spaced at suitable places. Sprinkler irrigation can be used for almost for all crops except rice. It is not suitable in very fine texture soil where infiltration rate are less than 4 mm/hr. This method is suitable for sandy soil that has a high infiltration rate. At the nozzle Pressure head is converted to Velocity head. Area of Land wetted depends on following factors: velocity of water jet, angle of flow, type of sprinkler & its design and wind speed & direction.
Adaptability depends on following factors:

1. Irregular Topography (Unsuitable for surface irrigation)
2. Gradient is steeper
3. Highly sandy soil
4. High Water Table
5. Seasonal water demand is low for that area

![Fig. 5 Layout of Sprinkler Irrigation System](image)

Crops having following factors:

1. Required Humidity Control (Tobacco)
2. Having shallow roots
3. Required high & frequent irrigation

**TYPES OF SPRINKLER IRRIGATION SYSTEM**

1. **Rotating Head System**
   A. Portable system
   B. Semi-portable system
   C. Solid Set system
   D. Semi Permanent System
   E. Permanent System
2. **Perforated Type System**

3. **Centre Pivot System** - Center pivot irrigation is a form of sprinkler irrigation. It consists of several segments of pipe which is joined together and is supported by trusses, mounted on wheeled towers with sprinklers positioned along its length. It moves in a circular pattern and is fed with water from the pivot point at the center of the arc.

![Fig. 6 Center pivot irrigation](image)

**Drip Irrigation** - Drip irrigation is sometimes called trickle irrigation, most efficient & effective way of irrigation and involves dripping water into the soil at very low rates (2-20 litres/hour) from a system of small diameter plastic pipes fitted with outlets called emitters or drippers. Water is applied close to plants so that only part of the soil in which the roots grow is wetted, unlike surface and sprinkler irrigation, which involves wetting the whole soil profile. It is suitable for high value row crops. Drip irrigation method can be either high tech computerized or labor intensive. Water is applied frequently but at a slow rate (<14lit/hr)

**Advantages of drip irrigation system:**

- Dia. of pipe & Emitters are small compared to Sprinkler Irrigation
- No need for separate drainage System.
- Full control over Weeds.
- Acceptable to any Farmable slope.
- Crop & Dippers are placed on contour lines to minimize discharge
- In Clayey soil, water application rate should be low.
- In Sandy Soil, Water Application Rate should be moderate.

**Disadvantage of drip irrigation system** - If water is not clean, then system may chock and deposition of Fertilizer (Ca & Na precipitate) would also cause chocking.
COMPONENTS OF A DRIP IRRIGATION SYSTEM

1. Drippers
2. Valves
3. Filters
4. Main line
5. Sub-Main line
6. Pump
7. Fertilizer tank (if any)

Valves Used:

1. Flow Control Valve
2. Non Return Valve
3. Pressure Regulating Valve
4. Pressure Relief Valve
5. Air & Vaccum Release Valve

Discharge Rates:

1. Low (Q < 4lit/hr)
2. Medium (4 < Q < 10Lit/hr)
3. High (Q < 15lit/hr)
REFERENCES

INTRODUCTION

Certain flowering plants (Phanerogams) also parasitize the crop plants in addition to the microorganisms. They mostly belong to Loranthaceae, Convolvulaceae, Scrophulariaceae, Orabanchaceae, Lauraceae, Santalaceae and Balauophoraceae. They produce flowers and seeds and parasitize their host by drawing nutrition and water. Some phanerogams have green leaves, roots and they have the ability to synthesis food materials but they obtain only the mineral constituents of food from the host, then they are called hemiparasite/waterparasite/partial parasite. Some of the phanerogams which do not have any chlorophyll completely depend on host for water and all minerals. They are called as holoparasite or complete or total parasite.

The phanerogamic plants are divided into:

1. **Stem parasite**
   - Total parasite: Cuscuta
     - C. campestris, C. trifoli, C. planiflora
     - Commonly known as gold thread, hellvine, hair weed, devils hair and love vine.
   - Semi parasite: Loranthus

2. **Root parasite**
   - Total parasite: Orabanche
   - Semiparasite: Striga

Phanerogams have haustoria as absorbing organ, which are sent deep into the vascular bundle of the host to draw water and nutrients. The haustoria in general secrete some pectolytic and cellulolytic enzymes which soften the host tissue. Haustoria have higher osmotic pressure than that of host tissue which facilitate easy absorption of nutrients. The affected plants show stunting, chlorosis and death.

Based on the habit and attachment of the parasite with the host, they are commonly grouped as stem parasite and root parasite. They are again divided into total or semi parasite depending upon their mode of parasitism.

a) **Stem parasite**

i) **Complete/holo/total parasite: Cuscuta sp.**

*C. campestris, C. trifoli, C. planiflora Dodder C. indicora*

Commonly known as gold thread, hellvine, hair weed, devils hair and love vine.
- Attacks alfalfa, clover, onion, flax, sugar beet, potato, chillies many ornamentals etc.
• It is a yellow or orange vine strands which grow and twin the plant. They do not have leaves but bear only very minute scale leaves. Dodder produces flowers and fruits. Flowers are white, pink or yellowish, which form seed.
- On severe infection, they form a dense and tangled mat on the crop.
• Seeds of dodder overwinter in the infested soil, germinate to produce a slender yellow shoot, make contact with the susceptible host plant, encircle and send haustoria into the vascular bundle of the host.
• It does not produce any roots. As soon as the dodder is established with the host, base of the dodder shrivels, dries and cut off from the ground. Thus it completely depends upon the host for nutrients and water.
• Thus the affected plants get weakened and yield poorly.
• Seeds of cuscuta are mainly spread by animals, water and implements.

ii) Partial semi / hemi stem parasite
Commonly known Loranthus, Giant mistletoe, Banda.

*Dendrophthae flacata*
(Order: Santalales; Family: Loranthaceae)
• Attacks mango, citrus, apple, rubber, guava etc.
• Partial parasite of tree trunks and branches with brown stem, dark green leaves but no roots.
• Stem of the parasite is usually thick, and flattened at the node, appears in clusters at the point of attack which can be easily spotted on the trees.
• At the point of attachment with the tree, it shows swellings or tumourous growth where the haustoria are produced.
• This parasite produces flowers which are long, tubular, greenish white or red and borne in clusters.
• It produces fleshy fruits with single seed. The affected host plant become stunted in growth with few small chlorotic leaves.
• Dispersal of the seed is mostly through the birds and to some extend by animals.

b) Root parasite / total/holo/complete parasite (eg)

• Commonly known as Broom rape or Tokra.
  • *O. cernuva* var. *dessertorum*, *O. robancre ramosa*, *O.minor*, *O. crenata*
  • (Order. Orchidales, Family. Orabanchaceae)
• It is a serious parasite in tobacco, tomato, brinjal, cabbage, cauliflower etc.
• It is an annual fleshy flowering plant growing to a height of about 10 - 15" with pale cylindrical stem, thickened at base and covered with brown scaly leaves that end in spikes.
• Plants lack chlorophyll, flowers arise from axils of the scale leaves.
• Flowers have well developed lobed calyx, tubular corolla, superior ovary, numerous ovules and large four lobed stigma. Fruits are capsules containing small black reticulate and ovoid seed.
• Seeds remain dormant in the soil for many years and they germinate due to a stimulant (benzopyran derivatives) present in the root exudate of susceptible host plant Ethylene, gibberellin and coumarins also induce the seed germination.
• In tobacco it appears in clusters of 50 - 100 shoots around the base of a single plant 5 - 6 weeks after transplanting. Affected tobacco plants are stunted, show withering and drooping of leaves leading to wilting.

ii) Hemi/partial/semi parasite.
**Commonly known as witch weed or striga.**
*S. asiatica* parasitise sorghum, maize and sugarcane
*S. densiflora* parasitise sorghum and sugarcane.
• Mostly affect the monocots
• It is a small plant with bright green leaves grows upto a height of 15 - 30 cm.
• It occurs in clusters of 10 - 20/host plant.
• *S. asiaticca* produces pink flowers while *S. densiflora* produces white flower with a pronounced bend in corolla tube.
• This phanerogam lack typical root hairs and root cap.
• Fruits contain minute seeds in abundance which survive in soil for many years.
• Seeds germinate after post harvest ripening of about two weeks, in response to the host stimulant *viz.*, strigol ethylene, cytokinin, gibberellin and couma in strigol.
• This parasite slowly attach to the host root by haustoria, grow below the soil surface and produce underground stem and roots for about 1-2 months. Then it grows faster and appears at the base of the host plant.
• Severe infection of striga causes yellowing and wilting of host leaves. Sometime the host plant may die.

**Deficiency diseases / Nutritional disorders**
Nitrogen, phosphorus, potash, calcium, sulphur, magnesium are required comparatively in large amounts to the crop, hence they are called as major elements while ferous, boron, manganese, zinc, copper, chloride and molyldenum are required in very small amount, so they are called as micro/minor/trace elements. They develop hunger signs in the crop plants. Such symptoms are called as non-parasitic diseases/physiogenic diseases/physiological disorders/nutritional disorders /abiotic diseases.

1. Nitrogen
This nutrient is essential for chlorophyll proteins, enzymes and for all other compounds. In case of deficiency, plant growth is reduced, leaves become yellow or light brown, stem become slender and short.
(eg) Red leaf of cotton, Chlorosis in rice.
2. Phosphorous
It is a constituent of phospholipids, nucleic acid and many proteins. Dark green leaves of deficient plants (lower leaves) become red to purple owing to the abnormal production of anthocyanin pigments. Sometimes, necrotic spots are noticed in the leaves and leaf margin showing scorching.
(eg) P. deficiency in sunflower, soyabean, peach.

3. Potash
It is important for carbohydrate and protein synthesis. Act as a catalyst for many reaction. Dull bluish colour leaves, tip burn, marginal scorching, brown spolling, rolling/curling of lamina, poor root growth and shortening of internode are observed.
(eg) Marginal drying in banana.

4. Calcium
Involves in regulation of permeability of membrane, activity of many enzymes. Affected plants have uneven leaf growth, lamina shows scorching,(brown) marginal chlorosis, killing of growing tip and leaf tissues
(eg) Blossom end rot of tomato.

5. Magnesium
It is the structural element of certain enzymes of CHO synthesis. It act as cofactor for certain enzymes.Leaves show chlorosis in the form of interveinal mottling, Midrib remain green and gives inverted 'V' shaped green portion near the base of leaves.
(eg) Mg deficiency in Tomato, potato.

6. Sulphur
Certain vitamins, coenzymes and amino acids contain sulphur.
Younger leaves show yellowing, roll upward and are brittle in nature
(eg) S' deficiency in coconut, cotton, citrus.

7. Iron
Many respiratory enzymes have iron. In chlorophyll synthesis, the element seems to play a catalytic role. Deficient plants bear leaves which become chlorotic with main veins remaining green.
(eg) chlorosis in sugarcane, grundnut, green netting of citrus.

8. Zinc
Component of many enzymes of auxin synthesis and CHO oxidation.
Deficient plants show interveinal chlorosis followed by necrosis. Affected plants have shorter internode and small leaves, poor fruit, seed setting. The citrus leaves exhibit inverted ‘V’ shaped symptoms
(eg) Khaira disease of rice folia cellosis of citrus.
9. Boron
Deficient plants are thicker and brittle, tender growing point die, root are thick and stunted, internode shortened, storage tissues may show cracks/rot in the central part.

10. Manganese
Co factor of several enzymes of cellular respiration, N metabolism and photosynthesis. Leaves of deficient plants show chlorosis, smallest vein remain green, finally chlorotic area become necrotic.
(eg) Mottle leaf in citrus
Pahala disease of sugarcane

11. Copper
Co-factor for several oxidative enzymes. Deficient plants bears marginal chlorosis and with withered tip. Die-back symptoms also noticed. In case of cereals, head become dwarfed and destorted.
(eg) exanthema in citrus
Reclamation disease of oat

12. Molybdenum
Involved in the reduction of nitrate to nitrate. Deficient plants bear mottled and necrotic leaves with thiner and dry leaf lamina. Distortion and death of growing tissue may also take place.
(eg) Whip tail of cauliflower /cabbage.

REFERENCES

PLANT QUARANTINE

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INTRODUCTION

The term ‘Quarantine’ means simply forty i.e., 40 days period. This was more commonly referred to the period of detention for ships arriving from countries subject to epidemic diseases such as the Bubonic plague, cholera and yellow fever. The crew and the passengers used to be compelled to remain isolated on board for sufficient period to permit the diseases to develop and be detected. The purpose of the health authorities was to establish adequate detention period. Later on, the term ‘Quarantine’ came to be only used for the detention and the practices connected with it. The term got associated from the human disease field to the animal disease field and later on adopted to cover protective methods for the exclusion of pests and diseases of agricultural and horticultural crops.

In strict sense ‘Plant Quarantine’ refers to the holding of plants in isolation until they are believed to be healthy. Now, broader meaning of the plant quarantine covers all aspects of the regulation of the movement of living plants, living plant parts/plant products between politically defined territories or ecologically distinct parts of them. Intermediate quarantine and post entry quarantine are used respectively to denote the detention of plants in isolation for inspection during or after arrival at their final destination.

IMPORTANCE

The entry of a single exotic insect or disease and its establishment in the new environment continues to cause great, national loss (table ) till such time it is brought under effective control. In certain cases a country has to spend a few million rupees before success in controlling the introduced insect pest or disease is achieved.

Losses caused by introduced plant diseases

<table>
<thead>
<tr>
<th>Disease</th>
<th>Host</th>
<th>Country</th>
<th>Introduced from</th>
<th>Losses caused</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canker</td>
<td>Citrus</td>
<td>U.S.A.</td>
<td>Japan</td>
<td>$ 13 million; 19.5 million trees destroyed</td>
</tr>
<tr>
<td>Dutch elm</td>
<td>Elm</td>
<td>U.S.A.</td>
<td>Holland</td>
<td>$ 25 million -$ 50,000 disease million</td>
</tr>
<tr>
<td>Blight</td>
<td>Chestnut</td>
<td>U.S.A.</td>
<td>Eastern Asia</td>
<td>$ 100-1000</td>
</tr>
</tbody>
</table>
Innovative Approach in Agriculture Farming

<table>
<thead>
<tr>
<th>Disease</th>
<th>Crop</th>
<th>Country</th>
<th>Country</th>
<th>Damage/Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powdery mildew</td>
<td>Grapevine</td>
<td>France</td>
<td>U.S.A</td>
<td>80% in wine production</td>
</tr>
<tr>
<td>Downy mildew</td>
<td>Grapevine</td>
<td>France</td>
<td>U.S.A</td>
<td>$50,000 million</td>
</tr>
<tr>
<td>Bunchy top</td>
<td>Banana</td>
<td>India</td>
<td>Sri Lanka</td>
<td>Rs.4 crores</td>
</tr>
<tr>
<td>Wart Potato</td>
<td>Potato</td>
<td>India</td>
<td>Netherlands</td>
<td>2500 acres infected</td>
</tr>
<tr>
<td>South American leaf blight</td>
<td>Rubber</td>
<td>Dutch – Brazil</td>
<td>Guiana</td>
<td>40,000 trees destroyed</td>
</tr>
<tr>
<td>Blue mould</td>
<td>Tobacco</td>
<td>Europe</td>
<td>U.K</td>
<td>$50 million</td>
</tr>
</tbody>
</table>

HISTORY

The first plant quarantine law was promulgated in Rollen, France in 1860 to suppress and prevent the spread of common barberry, the alternate host for wheat stem rust. Among other countries, the first few to establish plant quarantine services were Germany, France, Australia and the U.S.A. In India, legislative measures against crop pests and diseases was initiated under the Destructive Insects and pests Act of 1914 (DIP act) and it was passed by Governor General of India on 3rd February, 1914. Under this Act, rules governing the import and movement of plants and plant materials, insects and fungi are framed. The Act provides:

- It authorizes the Central Government to prohibit or regulate the import into India or any part thereof of any specific place therein, of any article of class of articles.
- It authorizes the officers of the Customs at every port to operate, as if the rules under the D.I.P. Act is made under the Sea Customs Act.

1. It authorizes the Central Government to prohibit or regulate the export from a State of the transport from one State to another State in India of any plants and plant materials, diseases or insects likely to cause or infestation. It also authorizes the control of transport and carriage and gives power to prescribe the nature of documents to accompany such plants and plant materials and articles.

2. It authorizes the State Governments to make rules for the detention, inspection, disinfection or destruction of any insect or class of insects or of any article or class of articles, in respect of which the Central Government have issued notifications. It also authorizes the State governments for regulating the powers and duties of the officers whom it may appoint on this behalf.

3. It provides penalty for persons who knowingly contravene the rules and regulations issued under the Act.

4. It also protects the persons from any suit or prosecution or other legal proceedings for anything done in good faith or intended to be done under the Act. Consequent to Bengal famine 1943, a Central Plant Protection organization was established in 1946 under the then Ministry of Food and Agriculture. Often a new pest, disease or weed has accidentally entered a country.
where it did not exist before and has multiplied, spread and caused enormous damage to the crops of that country.

For instance powdery mildew of grapevine (*Plasmopara viticola*), introduced into France from America, was responsible for the destruction of the vine industry of that country until hybridization with resistant American stock offered a solution. The blight disease of chestnut (*Endothia parasitica*) which was introduced into U.S.A. from Asia in 1904, completely wiped out chestnut trees. Coffee rust (*Hemileia vastarix*) which came into India in 1879 from Sri Lanka is now widespread in all coffee growing areas. Fire blight (*Erwinia amylovora*) of pear and other pomes which was introduced from England in 1940 is well established in Uttar Pradesh. Late blight (*Phytophthora infestans*) of potato introduced into India in 1889 from Europe is now present in many parts of the country. Flag smut (*Urocystis tritici*) of wheat introduced from Australia is now well spread in Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh. Rubber powdery mildew (*Oidium heavea*), which was introduced from Malaysia in 1938, is also causing great concern in Kerala. Black rot of crucifers (*Xanthomonas campestris pv. campestris*) believed to have been introduced to India with seeds imported from Holland, and other European countries after World War II, prevailed for some years on the hills and then spread to the plains and became established in Indian seed stocks, especially in West Bengal. Among the more important plant disease introductions, mention may be made of bunchy top virus of banana introduced from Sri Lanka in 1940 which has since spread widely in Kerala, Orissa, West Bengal and Assam. The wart disease (*Synchytrium endobioticum*) of potato was first noticed in Darjeeling district of West Bengal having been introduced with seed potatoes from Holland. By 1962, the disease spread over nearly 1000 ha and has recently been reported from Nepal also. The mosaic disease of banana is another introduced disease which is only confined to Gujarat and Maharashtra states. Recently the apple scab (*Venturia inaequalis*) which was only confined to small area in Jammu and Kashmir has now appeared in severe form in many locations in Himachal Pradesh, and is posing a problem to apple industry. The establishment of a plant quarantine regulation should rest on the following fundamental pre-requisites.

1. The pest/disease under consideration must be one that will offer actual or expected threats to substantial interests (Agricultural and / or commercial)
2. The quarantine regulation or degree must represent a measure for which no substitute action involving less interference with normal activities is available.

### Diseases believed to have been introduced into India from foreign countries

<table>
<thead>
<tr>
<th>Disease</th>
<th>Host</th>
<th>Date of first record</th>
<th>Introduction from</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf rust(<em>Hemileia vastarix</em>)</td>
<td>Coffee</td>
<td>1879</td>
<td>Sri Lanka</td>
</tr>
<tr>
<td>Late blight (<em>Phytophthora</em>)</td>
<td>Potato</td>
<td>Tomato 1883</td>
<td>Europe</td>
</tr>
<tr>
<td></td>
<td>Disease</td>
<td>Host</td>
<td>Year</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------------</td>
<td>---------------</td>
<td>------</td>
</tr>
<tr>
<td>Rust (Puccinia carthami)</td>
<td>Chrysanthemum</td>
<td>1904</td>
<td></td>
</tr>
<tr>
<td>Flag smut (Urocystis tritici)</td>
<td>Wheat</td>
<td>1906</td>
<td></td>
</tr>
<tr>
<td>Downy mildew (Pseudoperonospora cubensis)</td>
<td>Grapevine</td>
<td>1910</td>
<td></td>
</tr>
<tr>
<td>Downy mildew (Sclerospora philippinensis)</td>
<td>Cucurbits</td>
<td>1910</td>
<td></td>
</tr>
<tr>
<td>Downy mildew (Sclerospora philippinensis)</td>
<td>Maize</td>
<td>1912</td>
<td></td>
</tr>
<tr>
<td>Foot rot (Fusarium moniliforme var. majus)</td>
<td>Rice</td>
<td>1930</td>
<td></td>
</tr>
<tr>
<td>Leaf spot (Phyllachora sorghi)</td>
<td>Sorghum</td>
<td>1934</td>
<td></td>
</tr>
<tr>
<td>Powdery mildew (Oidium heveae)</td>
<td>Rubber</td>
<td>1938</td>
<td></td>
</tr>
<tr>
<td>Black shank (Phytophthora parasitica var. nicotianae)</td>
<td>Tobacco</td>
<td>1938</td>
<td></td>
</tr>
<tr>
<td>Fire blight Pear and other (Erwinia amylovora)</td>
<td>Pomes</td>
<td>1940</td>
<td></td>
</tr>
<tr>
<td>Crown-gall and hairy root (Agrobacterium tumefaciens A. rhizogenes)</td>
<td>Apple, Pear</td>
<td>1940</td>
<td></td>
</tr>
</tbody>
</table>

1. Bunchy top Banana 1940 Sri Lanka
2. Canker Apple 1943 Australia (Sphaeropsis malorum)
3. Wart Potato 1953 Netherlands (Synchytrium endobioticum)

Despite every precaution of inspection, certification and treatment, it is not always possible to guarantee that a consignment is completely free from pathogens. In doubtful cases it is advisable to subject plants to a period of growth in isolation under strict supervision in the importing country (post-entry quarantine). The plants are grown at a quarantine station. When direct importation of plants to a country’s own quarantine station is considered very dangerous, quarantine during transit from the country of origin (intermediate quarantine) may be required. The requirements of an intermediate station are similar to those for a post-entry station. Intermediate quarantine inspection must always be followed by post-entry quarantine after arrival of the consignment at its final destination. During post-entry or intermediate quarantine plants must be kept under close supervision, so that any pest or disease which appears may be
Innovative Approach in Agriculture Farming

immediately detected and grown under optimum conditions, so that symptoms are not marked by physiological disturbances. International plant protection convention the first effort towards international agreement on Plant Protection was made in 1914 under the auspices of the International Institute of Agriculture in Rome. This was followed by an International Convention of Plant Protection by over 50 member countries of the Institute in 1919 and certain Agreements regarding the issue and acceptance of phytosanitary certificates were finalized. The project received a set back due to Second World War and was later on revived by the FAO. In post-war period International action in Plant Protection and particularly in plant quarantine was encouraged by FAO with the establishment in 1951 of the International Plant Protection Convention. This agreement was constituted with the purpose of securing common and effective action to prevent the introduction and spread of pests and diseases of plants and plant products as to encourage Governments to take all steps necessary to implement its prevention (Ling, 1953).

The following regional Plant Protection Organizations are now in operation.
1. The European and Mediterranean Plant Protection Organization (EPPO)
2. The Inter-African Phytosanitary Council (IAPSC)
3. Organismo International Regional de Sanidad Agropecuaria (OIRSA)
4. The Plant Protection Committee for, the South East Asia and Pacific region.
5. Comité Interamericano de Protection Agrícola. (CIPA)
6. The Caribbean Plant Protection Commission (CPPC)

Under article 3 of that International Plant Protection Convention, the Plant Protection Agreement for South East Asia and Pacific Region was sponsored by F.A.O in 1956, and India became in party to this Agreement in the same year the along with Australia, Sri Lanka, the U.K., Laos, Netherlands, Indonesia, Portugal and Vietnam. Our Government agreed to adopt legislative measures specified in the Convention for the purpose of securing common and effective action to prevent the introduction and spread of pests and diseases of plants and plant products and to promote measures for their control and also agreed to assume all responsibilities for the fulfillment within its territories of all requirements under the Convention. It was agreed that the Government shall make provision for:
a. An official plant protection organization, with the following main functions:
1. The inspection of growing plants, of areas under cultivation and of plants and plant products in storage and in transportation with the object of reporting the existence, outbreak and spread of plant diseases and pests and of controlling those pests and diseases.
2. The inspection of consignments of plants and plant products moving in international traffic, the inspection of consignments of other articles or commodities moving in international traffic under conditions where they may act incidentally as carriers of pests and diseases of plants and plant products and the inspection and supervision of storage and transportation facilities of all

(201)
kinds involved in international traffic whether of plants and plant products or other commodities, with the object of preventing the dissemination across national boundaries of pests and diseases of plants and plant products.
3. The disinfestation or disinfection of consignments of plants and plant products moving in international traffic, and their containers, storage places, or transportation facilities of all kinds employed.
4. The issue of certificates relating to phytosanitary condition and origin of consignments of plants and plant products (Phytosanitary certificates).
b. The distribution of information within the country regarding the pests and diseases of plants and plant products and the means of their prevention and control
c. Research and investigation in the field of plant protection. A revised text of convention was approved in 1979. As of December 1980, the number of states party to the convention is Besides this world-wide convention, other regional agreements and organizations have been created to safeguard the interests of groups of neighbouring countries with similar plant protection problems.

Regional action is needed to prevent a pathogen or pest absent from a whole area from being introduced into any part of the area, as its entry into one territory will endanger neighbouring countries.

PLANT QUARANTINE METHODS
There are number of plant quarantine methods which are used separately or collectively to prevent or retard the introduction and establishment of exotic pests and pathogens.

The components of plant quarantine activities are:
1. Complete embargoes
It involves absolute prohibition or exclusion of specified plants and plant products from a country infected or infested with highly destructive pests or diseases that could be transmitted by the plant or plant products under consideration and against which no effective plant quarantine treatment can be applied or is not available for application.
2. Partial embargoes
Partial embargoes, applying when a pest or disease of quarantine importance to an importing country is known to occur only in well defined area of the exporting country and an effectively operating internal plant quarantine service exists that is able to contain the pest or disease within this area.
3. Inspection and treatment at point of origin
It involves the inspection and treatment of a given commodity when it originates from a country where pest/disease of quarantine importance to importing country is known to occur.
4. Inspection and certification at point of origin
It involves pre-shipment inspection by the importing country in cooperation with
Exporting country and certification in accordance with quarantine requirements of importing country.

5. Inspection at the point of entry
It involves inspection of plant material immediately upon arrival at the prescribed port of entry and if necessary subject to treatment before the same related.

6. Utilization of post entry plant quarantine facilities
It involves growing of introduced plant propagating material under isolated or confined conditions.

PLANT QUARANTINE ORGANIZATIONS IN INDIA
The first recorded plant quarantine measure in India dates back to 1906 when perceiving the danger of introducing the Mexican boll weevil, the Government of India directed that all cotton imported from the New World should only be admitted to India after fumigation with carbon disulphide at the port of entry. In India two categories of regulatory measures are in operation for controlling pests, diseases and weeds. In the first category regulatory measures are aimed to prevent the introduction of exotic pests and diseases into the country or their spread from one State or Union Territory to another (Plant Quarantine). The second pertains to suppression or prevention of spread of pests and diseases in localized areas within a State or Union Territory. The former derives its authority from the Destructive Insects and Pests (DIP) Act 1914 of the Central Government and the latter from Agricultural Pests and Diseases Acts of the various States. The legislative measures against crop pests and diseases were initiated under the DIP Act of 1914 which was passed by the then Governor General of India in Council on 3 February 1914. Prior to the establishment of the Directorate of Plant Protection, Quarantine and Storage in 1946, under the Ministry of Food and Agriculture, the various rules and regulations of the DIP Act were enforced by the customs department. The quarantine regulations are operative through The Destructive Insects and Pests Act, 1914 (which has been revised 8 times from 1930 to 1956 and amended in 1967 and 1992.

The provisions of the DIP Act are
1. It authorizes the Central Government to prohibit or regulate the import into India or any part thereof or any specific place therein of any article or class of articles.
2. It authorizes the officers of the Customs at every port to operate, as if the rules under DIP Act are made under the Sea Customs Act.
3. It authorizes the Central Government to prohibit or regulate the export from a State or the transport from one State to another State in India of any plants and plant material, diseases or insects, likely to cause infection or infestation. It also authorizes the control of transport and carriage and gives power to prescribe the nature of documents to accompany such plants and plant materials and articles.
4. It authorizes the State Governments to make rules for the detention, inspection, disinfection or destruction of any insect or class of insects or any article or class of articles, in respect of which...
the Central Government has issued notification. It also authorizes the State Governments for regulating the powers and duties of the officers whom it may appoint on its behalf.

5. It provides penalty for persons who knowingly contravene the rules and regulations issued under the Act.

The quarantine regulations are operative through “The Destructive Insects and Pests Act, 1914 (which has been revised and time from 1930 to 1956 and amended in 1967 and 1992. The Act also empowers the State Governments to frame suitable rules and issue notifications for inter-state movement of plant and plant material. Those rules are known as plant quarantine rules. Under the Act, Central Government frames rules prescribing the seaports, airports and land frontiers through which plants and specified plant material can enter India, and the manner in which these can be imported. The DIP Act operates under the National Sea Customs Act and the points of entry are located within the jurisdiction of State on the advice of Central Government, the State frames rules for detention, inspection, disinfection and destruction (as against entry) of material, if required, and delegates powers in this regard to concerned authorities with the enforcement of rules.

The plant quarantine service is centrally organized and administered through the Directorate of Plant Protection, Quarantine and Storage established under the Ministry of Agriculture (Department of Agriculture and Co-operation) which is headed by the Plant Protection Adviser to the Government of India and having its headquarters at N.H. IV, Faridabad, Haryana State. Import regulations When plants are imported the following principles should be followed. Some plant pathogens and pests are generally distributed in most parts of the world but others are more or less restricted in their occurrence.

In some cases this limitation is due to such factors as unsuitable environmental conditions or lack of the required host plant, but in many other cases the absence of a pathogen. Most countries are aware of the desirability of delaying for as long as possible the arrival of exotic pathogens and take action to prevent their spread by introducing legislation and setting up organizations to prevent their entry. Plant quarantine legislation varies from country to country but in most cases it restricts or prohibits the importation of the pests or pathogens themselves, plants on which they might be living, soil which might be infested, foodstuffs which might carry them, and packing materials, particularly those of plant origin. Good legislation is as brief and clear as possible, at the same time being easy to interpret, gives adequate protection without interfering more than is essential with trade, and contains only restrictions which are scientifically justifiable. When plants are imported there are certain principles which, if followed ensure that as few risks as possible are taken.

1. Import from a country where, for the crop in question, pathogens which are particularly to be guarded against are absent.

2. Import from a country with an efficient plant quarantine service, so that inspection and
treatment of planting material before despatch will be thorough, thus reducing the likelihood of contaminated plants being received.

3. Obtain planting material from the safest known source within the selected country.

4. Obtain an official certificate of freedom from pests and diseases from the exporting country. Treatment of the material in the country of origin may be done; this should be noted on the certificate.

5. The smaller the amount the less the chance of its carrying infection, and inspection as well as post-entry quarantine.

6. Inspect material carefully on arrival and treat (dust, spray, fumigate, heat treat) as necessary.

7. Import the safest type of planting material, e.g. seeds are usually safer than vegetative material, unrooted cuttings than rooted. The use of axenic cultures of meristem tip tissues (micropropagation) for the international exchange of germplasm material has outstanding advantages, as such tissues can be expected to be free from latent infections by viruses, phytoplasmas etc., as well as other pathogens which are more readily detectable by visual means.

8. If other precautions are not thought to be adequate, the consignment for import should be subject to intermediate or post-entry quarantine. Such quarantine must be carried out at a properly equipped station with suitably trained staff.

Seed was not originally included in the DIP Act, but because of the changing situation and to meet the current requirements, the Government of India passed the Plants, Fruits, Seeds (Regulation of Import into India) Order 1984 which came into effect in June 1985. The conditions for the import of 17 crops are stipulated in this order. The main features of the order are:

1. Seed has been brought under the purview of the DIP Act.
2. No consignment can be imported into the country without valid import permit issued by the Plant Protection Adviser to the Government of India.
3. No consignment can be imported without an official phytosanitary certificate issued by the plant quarantine agency of the exporting country.
4. Post-entry growth of the specified crops at approved locations.

A. Conditions for import
In India, there are general and specific conditions for the import of plants (including bulbs, tubers, rhizomes, corms, cuttings, buddings, grafts, layers, suckers, roots and flowers) and plant materials (including plant products such as ginned cotton, unmanufactured tobacco etc.).

General conditions
1. Import permits are essential for:
a. Seeds and fruits for consumption,
b. Seeds and plants for sowing or planting,
c. Soil, earth clay for microbiological, soilmechanics or mineralogical investigations
d. Peat for horticultural purposes
e. Live insects and f. Living fungi in pure culture, including *Rhizobium cultures*.

2. All plants should be accompanied by Phytosanitary certificate from the country of origin.
3. All plants on arrival at port, shall be inspected and if necessary fumigated, disinfested or disinfecte by Plant Protection Adviser to the Government of India or any other officer authorized by him on his behalf.
4. Plants and seeds which require post-entry quarantine inspection shall be grown in post-entry quarantine facilities approved by the Plant Protection Adviser to the Government of India.
5. Import of hay or straw or any material of plant origin used for packing is prohibited.
6. Import of soil, earth, compost, sand, plant debris along with plants, fruits and seeds is prohibited.

*Note:* Cut flowers, garlands, bouquets, fruits and vegetables weighing less than 2 kg for personal use may be imported without a permit or phytosanitary certificate, but are subject to inspection.

Special conditions In addition to the general conditions, there are special conditions for certain notified plants as follows.

### 1. Prohibition from certain areas

<table>
<thead>
<tr>
<th>Name of the plant</th>
<th>Countries from where prohibited</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocoa and all species of Sterculiaceae</td>
<td>Africa, Sri Lanka, West Indies and Bombaceae</td>
</tr>
<tr>
<td>Coffee beans</td>
<td>Africa, South America, Sri Lanka</td>
</tr>
<tr>
<td>Rubber</td>
<td>South America, West Indies</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>Australia, Fiji, Papua New Guinea</td>
</tr>
<tr>
<td>Sunflower</td>
<td>Argentina, Peru</td>
</tr>
</tbody>
</table>

1. Prohibited for general public: Coconut plants and seeds, coffee plants and seeds, cotton seeds and unginned cotton, forest tree seed (*Castanea, Pinus, Ulmus*), groundnut seeds and cuttings, potato, sugarcane, tobacco seeds and wheat seeds.
2. Plants/seeds which require post entry quarantine: Cocoa, citrus, coconut, groundnut, potato, sugarcane, sunflower, tobacco and wheat.
3. Additional declarations required for notified plants (see Table below)
**Plant/seed Additional declarations for freedom of pests**

<table>
<thead>
<tr>
<th>Crop/Plant</th>
<th>Disease/Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>All species of <em>Allium</em> (onion, garlic, leek, chive, shallot, etc.)</td>
<td>Smut (<em>Urocystis cepulce</em>)</td>
</tr>
<tr>
<td>Cocoa and all species of the family Sterculiaceae and Bombaceae</td>
<td>Pod rot (<em>Monilia rorei</em>), Mealy pod (<em>Trachysphaeria and fructigena</em>), Witches’ broom (<em>Crinipellia perniciosus</em>) Swollen shoot virus</td>
</tr>
<tr>
<td>All species of <em>Citrus</em> (lemon, lime, orange etc.,)</td>
<td>Mal Secco (<em>Deuterophoma tracheiphila</em>)</td>
</tr>
<tr>
<td>Coconut seeds and all species of <em>Cocos</em></td>
<td>Lethal yellowing, Cadang, Bronze leaf wilt, Guam, Coconut disease, Leaf scorch</td>
</tr>
<tr>
<td>Coffee – plants, seeds American leaf spot (<em>Omphali flavida</em>), virus diseases Cotton seeds</td>
<td>Bacterial blight (<em>Xanthomonas axonopodis pv. malvacearum</em> and <em>Glomerella gossypii</em>)</td>
</tr>
<tr>
<td>Forest tree seeds (all species <em>Cronartium ribicola</em>, <em>Endothea of Pinus, Ulmus, Castanea</em>)</td>
<td>parasitica, <em>Ceratocystis ulmi</em>, <em>Dothiostroma pini</em>.</td>
</tr>
<tr>
<td>Lucerne (all species of <em>Medicago</em>)</td>
<td>Bacterial wilt (<em>Corynebacterium incidiosum</em>)</td>
</tr>
<tr>
<td>Potato (all species of <em>Solanum</em>)</td>
<td>Wart (<em>Synchytrium endobioticum</em>) and freedom of parent crop from virus diseases</td>
</tr>
<tr>
<td>Rubber (all species of <em>Hevea</em>)</td>
<td>South American leaf blight (<em>Microcyclus ulei</em>, <em>Sphaerostilbe repens</em>)</td>
</tr>
<tr>
<td>Sugarcane (all species of <em>Saccharum</em>)</td>
<td>Leaf scald (<em>Xanthomonas albineans</em>), Gummosis (<em>Xanthomonas vasculorum</em>), Sereh, downy mildew, chlorotic streak and Fiji disease.</td>
</tr>
</tbody>
</table>

**AGENCIES INVOLVED IN PLANT QUARANTINE**
The authority to implement the quarantine rules and regulations framed under DIP Act rests basically with the Directorate of plant Protection, Quarantine & Storage, under the Ministry of Agriculture. This organization handles bulk import and export of seed and planting material for commercial purpose. Under this organization 9 seaports, 10 airports and 7 land frontiers are...
functioning. These are the recognized ports for entries for import of plant and plant material. The names and places of the ports and stations are as follows.

A. Seaports - Place State / Union territory
1. Bhavnagar - Gujarat
2. Calcutta - West Bengal
3. Chennai - Tamil Nadu
4. Cochin - Kerala
5. Mumbai - Maharashtra
6. Nagapattinam - Tamil Nadu
7. Rameswaram - Tamil Nadu
8. Tuticorin - Tamil Nadu
9. Visakhapatnam - Andhra Pradesh

B. Airports
1. Amritsar - Punjab
2. Calcutta - West Bengal
3. Chennai - Tamil Nadu
4. Hyderabad - Andhra Pradesh
5. Mumbai - Maharashtra
6. New Delhi - New Delhi
7. Patna - Bihar
8. Tiruchirappalli - Tamil Nadu
9. Trivandrum - Kerala
10. Varanasi - Uttar Pradesh

C. Land frontiers
1. Amritsar Railway Station - Punjab
2. Attari Railway Station - Punjab
3. Attari-Wagah Border- Punjab
4. Bangaon Benapol Border - West Bengal
5. Gede Road Railway Station - West Bengal
6. Kalimpong - West Bengal
7. Sukhia Pokhri - West Bengal

The Government of India has also approved three other national institutions to act as official quarantine agencies, especially for research material.
1. National Bureau of Plant Genetic Resources (NBPGR)

The NBPGR in New Delhi and its regional station at Hyderabad in the agency involved in processing of germplasm, seed, plant material of agricultural, horticultural, and silvicultural crops of all the institutions of Indian Council of Agricultural Research (ICAR) functioning in the country. It is also responsible for quarantine clearance of seed and plant material received from International Agricultural Research Centers *viz.*, ICRISAT, ICARDA, CIMMYT, etc. ICRISAT was established in 1972 at Patancheru (near Hyderabad) to work on improvement of sorghum, pearl millet, chickpea, pigeonpea and groundnut. The quarantine clearance of all its exchanges was handled by Central Plant Protection Training Institute of Directorate of Plant Protection, Quarantine & Storage, until July 1986. This authority was later passed on to NBPGR in August 1986.

2. Forest Research Institute (FRI), Dehra Dun, for forestry plants and
3. Botanical Survey of India (BSI) for other plants.

Quarantine inspection, treatment and certification procedures

Inspection: Inspection of plant material is an important part of plant quarantine procedure, and may be done both in the exporting country, before issue of a health certificate and after arrival to detect any pest or disease which may have become evident during transit. Publications like manuals, handbooks on individual organisms of quarantine importance are prepared with illustration by each country / region to help inspectors. The following series published by Commonwealth Mycological Institute ill be useful for all countries.

1. CMI descriptions of pathogenic fungi and bacteria
2. CMI/AAB descriptions of plant viruses and
3. CMI distribution maps of plant diseases.

The various steps involved in import quarantine clearance of seed and propagating plant material is outlined below

i. Securitization of import application filed along with attached documents such as phytosanitary certificate (original), permit (importer’s copy), shipping bill, invoice, packing list and customs bill of entry etc., to ensure the import is in order and that no prohibited plant material is imported.

ii. Assessment of inspection fees and registration of application.

iii. Inspection and sampling of the consignment at port warehouses or container terminal.

Sampling of seed usually carried out as per the provisions of ISTA Rules and Regulations. Whereas in case of bulk import of vegetative planting material such as cuttings/saplings/ bud woods/ bulbs/ tubers etc., at least a minimum of 0.1% of propagules are sampled variety and examined to ensure free from exotic pests or pathogens. In case of quarantine pests suspected, 100 per cent inspection is carried out for critical assessment of the risk.

iv. Detailed laboratory testing
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a. Visual inspection: The samples of seed/propagating plant material is examined with the help of illuminated magnifier to record live insect infestation, contamination by soil and weed seeds, nematode galls, sclerotia, smut/bunt balls etc. Sometimes inspections are carried out under U.V. lamp to facilitate detection of specific seed-borne inspection by characteristic fluorescence.

b. X-Ray test for detecting hidden insect infestation such as bruchids and weevils that bore into seed.

c. Washing test to detect surface-borne oospores of downy mildew/smut spores/bunt spores etc. and nematode cysts. Seed samples of onion, clover and lucerne are soaked for 24 to detect stem and bulb nematode and also root washings are examined for ectoparasitic nematodes.

d. Incubation tests such as blotter test or agar plate test carried out for detecting seed-borne pathogens such as fungi. Fluorescent pseudomonas agar used for selective detection of seedborne bacteria.

e. Grow-out test coupled with indicator inoculation tests for detecting seedborne viruses and bacteria. Besides this, special diagnostic tests such as Electron Microscopy (dip method), Enzyme Linked Immunosorbent Assay (ELISA) are used for detection of specific viruses in the imported seed/planting material pencillnase based DAC-ELISA is widely used for the detection of virus in imported seed/plant material. The detailed testing procedures for the detection of seed-borne pathogens are outlined in the seed health testing chapter.

v. Fumigation and treatment techniques

Fumigation is the versatile technique used for eliminating insect infestation. Methyl bromide is the most commonly employed for controlling insect infestation and readily adopted in quarantine programmes as the exposure time involved is short and affect all stages of insect pests and high penetrating power. Two types of fumigation viz., i. atmospheric fumigation under gas-proof sheets or chambers and ii. vacuum fumigation in vacuum chamber is widely employed. The other chemical treatments include insecticidal/fungicidal drippings or spraying or seed dressings are invariably associated with growing under post-entry quarantine conditions. The temperature treatments such as hot water treatment/hot air treatment or vapour heat treatment are carried out control internally borne infection/infestation and the latter particularly employed to control fruit fly infestation. Cold treatments such as refrigeration to control insect infestation in fresh fruits and vegetables. Of late, irradiation is used to control insect infestation and spoilage of food products during storage and as well as application of high intensity electronic beams through an accelerator is under experimentation.

CERTIFICATION

Phytosanitary or health certificate is a certificate which should accompany a plant or plant material or seed which is to be moved from one place to another place. This certificate indicates or certifies that the material under transit is free from pests or diseases. A model phytosanitary certificate proposed at the Government consultation on the International Plant Protection convention at Rome in 1976 (Chock, 1977) and approved by F.A.O. in 1979 is given below.
MODEL PHYTOSANITARY CERTIFICATE
(to be typed or printed in block letters)

Plant Protection Organization No. _______________ of _____________________
To: Plant Protection Organization(s) of

DESCRIPTION OF CONSIGNMENT
Name and address of exporter ______________________________Declared
name and address of consignee ___________________________Number and
description of packages _______________________________Distinguishing marks
__________________________________________Place of origin
__________________________________________Declared means of
conveyance ________________________________Declared point of entry
__________________________________________Name of produce and quantity
declared _________________________________Botanical name of plants

This is to certify that the plants or plant products described above have been inspected according
to appropriate procedures and are considered to be free from quarantine pests and practically free
from injurious pests; and that they are considered to conform to the current phytosanitary
regulations of the importing country.

DISINFESTATION AND/OR DISINFECTION TREATMENT
Date _____________________ Treatment
_________________ Chemical (active ingredient) ____
Duration and temperature _____ Concentration
_________________ Additional information _______

Additional declaration:
(Signature)
Note: No financial liability with respect to this certificate shall attach to..... (name of plant
protection organization)... or to any of its officers or representatives.

DOMESTIC QUARANTINE
Under the DIP Act, the Directorate of Plant Protection, Quarantine and storage has the
responsibility to take the necessary steps and regulate the inter-state movement of plants and
plant material in order to prevent the further spread of destructive insects and diseases that have
already entered the country. The sole object of enforcing domestic quarantine is to prevent the
spread of these diseases from infected to non-infected areas. Currently, domestic plant quarantine
exists in four diseases, wart (*Synchytrium endobioticum*) of potato from 1959, bunchy top (virus)
of banana from 1959, mosaic (virus) of banana from 1961 and apple scab (*Venturia inaequalis*)

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from 1979. Most of the states in India have plant quarantine laws to avoid entry of plant pests and diseases.

1. **Bunchy top of banana**: The export and the transport from the States of Assam, Kerala, Orissa, West Bengal, Tamil Nadu to any other State of Banana plant or any other plant of the genus *Musa*, including sucker, stem, leaf, flower, and any other part thereof which may be used for propagation, or the materials of banana plant or any other plant of the genus *Musa*, which are used for packing and wrapping, excluding the banana fruit is prohibited.

2. **Banana mosaic**: The export and transport from the States of Maharashtra and Gujarat of any plant of Banana or any other plant of genus *Musa* including the sucker, stem, flower and any other part thereof, but excluding leaf and fruit thereof is prohibited; vide Government of India notification No. F. 6-10-PPS dated the 11th April, 1961.

3. **Potato wart**: The export to potato tubers from the State of West Bengal to any other State or territory of India is prohibited.

4. **Apple scab**: The Directorate of Horticulture, Himachal Pradesh worked out a detailed scheme for the eradication of scab, and also issued a notification No.NIC.20/76 dated 28 December 1978, prohibiting the export of planting material of apple outside the State.

In Tamil Nadu as per Madras pests and Diseases Act of 1919, quarantine regulations are periodically enforced. e.g., cardamom mosaic prevalent in Anamalai area of Coimbatore District and is free from Nelliampatti area. Hence the movement of diseased plant material from Anamalai to Nelliampatti area is prevented.

**Limitations**

There are many limitations to implementing domestic plant quarantine in India due to the vastness of the country and the unrestricted movement of plant material from one state to another. As a result the diseases like bunchy top and mosaic of banana have spread to several other states. However, the wart disease, golden nematode of potato, and scab of apple are restricted in the states where they were initially noticed.

**Export regulations**

In India the plant quarantine measures for exporting plants and material including seeds have been streamlined and rigid inspections are enforced before the material is allowed to be landed into the country. At present plant quarantine regulations differ with different countries for major agricultural commodities that are being exported out of India. The Central Government has authorized officers of the Directorate of Plant Protection, Quarantine & Storage, ICAR Research Institutes, National Institutes like Forest Research Institute, Botanical Survey of India, and the Directorates of Agriculture of all States.

The quarantine authorities have also framed terms and conditions pertaining to inspection, fumigation or disinfection of the exportable plants and plant material in India including the following schedule/or fee for inspection and issue of phytosanitary certificate, and/or fumigation...
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or disinfection in respect of plants, plant material, seeds, and plant products to issue phytosanitary certificate. All the plants and plant material are subjected to inspection by officials issuing certificate. Infested materials are given necessary treatment with chemicals and fumigated if necessary.

The list of plant quarantine and fumigation stations in India is given below.

**Punjab**
1. Plant Quarantine and Fumigation Station, Hussainiwala, Ferozepur District.
3. Plant Quarantine and Fumigation Station, Civil Aerodrome, Rajasansi, Amritsar.

**New Delhi**
1. Plant Quarantine and Fumigation Station, Palam Airport, New Delhi – 10.
2. Plant Quarantine and Fumigation Station, Garden Reach Road, Calcutta–24.
3. Plant Quarantine and Fumigation Station Sukhiapokri, Darjeeling District.

**Gujarat**
1. Plant Quarantine and Fumigation Station, Haryana Plot No.75, Behind Yusuf Bagh

**Maharashtra**
1. Plant Quarantine and Fumigation Station, Haji Bunder Road, Sewri, Mumbai

**Andhra Pradesh**

**Tamil Nadu**
1. Plant Quarantine and Fumigation Station, 6, Clive Battery, Chennai – 1.
2. Plant Quarantine and Fumigation Station, 335, Beach Road, Tuticorin – 1.
3. Plant Quarantine and Fumigation Station, Tiruchirappalli Airport, Tiruchirappalli.
4. Plant Quarantine and Fumigation Station, 110, Railway Feeder Road, Rameswaram.

**Kerala**
1. Plant Quarantine and Fumigation Station, Willingdon Island, Cochin – 3

**REFERENCES**
SOIL EROSION AND ITS CONTROL MEASURES: A BRIEF DESCRIPTION

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INTRODUCTION

Soil and Water are the two most important resources that are available on the Earth on which various processes depend. The sustenance of humans, animals and various microorganisms is dependent on soil and water. Soil is created by weathering acting on rocks.

According to the Soil Science Society of America Glossary of Soil Science Terms, the soil is defined in two ways

(i) The unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants.

(ii) The unconsolidated mineral or organic matter on the surface of the Earth that has been subjected to and shows effects of genetic and environmental factors of: climate (including water and temperature effects) and macro- and microorganisms, conditioned by relief, acting on parent material over a period of time. A product-soil differs from the material from which it is derived in many physical, chemical, biological and morphological properties and characteristics.

Soil serves as a media for production of food, feed fuel and fiber. It regulates water flow through terrestrial water cycle. It acts as a sink of greenhouse gases. It provides habitat to various animals that live in it. It also serves as an engineering media for construction of various structures. These are some of the functions of soil as a resource. Alike other resources available on the Earth, soil is also being continuously subjected to exploitation. This exploitation has ill effect in form of erosion of the soil. Soil erosion is defined as the process of detachment, transportation and deposition of soil particles form one place to another due to the action of rain, wind or water in action. Soil erosion is a natural process but it has increasingly been exacerbated by human activities.

1. TYPES OF SOIL EROSION

Soil erosion is basically of two types:

1.1 Geological erosion: It is also known as ‘natural’ or ‘normal’ erosion. It is natural process which is relatively slow so that it often goes unnoticed. It is responsible for loss and formation of soil simultaneously. It occurs over a long geologic time and is often not influenced by human activities.
1.2 **Accelerated erosion:** When the rate of soil erosion surpasses a certain threshold and becomes rapid, it is known as accelerated erosion. It is also known as anthropogenic or man induced erosion. This type of erosion is triggered by anthropogenic causes such as deforestation, shifting agriculture, intensive ploughing, intensive and uncontrolled grazing, and forest burning.

Accelerated erosion is divided into two forms:

1.2.1 **Water erosion:** It refers to washing away of soil by water from rain, runoff, snowmelt and irrigation. The main types of water erosion are splash, inter-rill, rill, gully, streambank and tunnel erosion. Splash erosion is defined as displacement of soil particles from their original position under the effect of raindrops impacting the soil surface. As soon as it starts, runoff promptly develops minute rills, and the portion of runoff that flows between rills is called sheet or inter-rill erosion. Some particles are carried away in runoff flowing in a thin sheet and some concentrate in small rills. Inter-rill erosion is the most common type of soil erosion. Splash and inter-rill erosion together make up about 70% of total soil erosion and occur simultaneously although splash erosion dominates during the initial process. Rill erosion occurs due to concentrated flow rather than shallow flow in small channels or rills. Runoff water concentrated in rills erodes soil at rapid rates than inter-rill erosion. The force of flow and the soil particles moving along the rill bed enlarge rills. Rill erosion is the second most common form of soil erosion. The rills can be easily eliminated by tillage operations but can cause large soil erosion especially under intensive rains. When further erosion continues in rills, they get enlarged and get converted to gullies. Gullies are primarily formed by concentrated runoff converging in lower points of the field. There are two types of gullies viz. ephemeral and permanent gullies. Ephemeral gullies are shallow channels that can be easily amended by tillage operations. On the other hand, permanent gullies are too large to be smoothened by regular tillage or crossed by farm implements and require expensive measures of reclamation and control. Gullies are normally back filled with soil from neighboring fields which reduces the topsoil depth. Tunnel erosion is also known as pipe erosion. It is the underground soil erosion and is common in arid and semi-arid area. Soils with highly erodible and sodic B horizons but stable A horizons are prone to tunnel erosion. Streambank erosion is defined as the breakdown of banks along streams, creeks, and rivers due to the erosive power of runoff from uplands fields.

1.2.2 **Wind erosion:** It is also known as Aeolian erosion. It is a dynamic process by which soil particles are detached and transported by erosive forces of the wind. It occurs when the force of wind exceeds the threshold level of soil’s resistance to erosion. The soil particles are transported by three processes under wind erosion namely, suspension, saltation and surface creep. Small particles (<0.1 mm) from pulverized soils are favorably transported in suspension, medium-sized particles (0.1–0.5 mm) in saltation, and large particles (0.5–2 mm) by surface creeping. Because of abrasion, rebounding, and rebouncing effects, saltating and creeping particles can be broken into smaller particles and be transported in suspension. Saltation, suspension, and surface creep are not separate but interactive and simultaneous processes of transport.
1.3 Harmful effects of soil erosion

There are many detrimental effects of soil erosion. Some of those effects are as follows:

(i) The top fertile soil is lost due to erosion which adversely affects the crop production and productivity.

(ii) The soil eroded from one place gets deposited into channels at other place in form of silts thus reducing the carrying capacity of channels, streams and rivers. This leads to problem of flooding.

(iii) The silting of reservoirs and other storage facilities reduces their capacity and useful life.

1.4 Measures of Soil Erosion control

Soil erosion cannot be avoided completely, but it can be controlled to some extent. It can be controlled by using some biological/vegetative/agronomical and engineering/mechanical measures.

1.4.1 Biological/vegetative/agronomical measures of erosion control

Numerous biological and agronomic management practices are used for controlling soil erosion. Important among these are no-till, reduced tillage, crop rotations, cover crops, vegetative filter strips, riparian buffers, agroforestry, and soil synthetic conditioners. Some of these measures are discussed as under:

1.4.1.1 Strip cropping: It is the practice of growing strips of crops having poor potential for erosion control, such as root crops, cereals etc., alternated with strips of crops having good potential for erosion control, such as fodder crops, grasses etc. which are close growing crops. The close growing crops act as an obstacle to the flow and reduce the runoff velocity generated from the strips of inter-tilled crops, and ultimately reduce soil erosion. Strip cropping system is of three forms namely contour strip cropping, buffer strip cropping and field strip cropping.

1.4.1.2 Contouring: It is the practice of cultivation of crops on contour lines, laid across the prevailing slope of the land. The intercultural operations create contour furrows, which along with plant stems act as very good barriers to the water flowing down the slope. These ridges also hold up water for a longer period of time, which, in turn, increases the opportunity time for the runoff water to infiltrate into the soil. In this way contouring helps in reducing the soil erosion. The magnitude of control of control of soil erosion by this method varies with the land slope, crop cover and soil texture.

1.4.1.3 Reduced or minimum tillage: Reduced tillage refers to any conservation system that minimizes the total number of primary and secondary tillage operations for planting from that normally used on field under conventional tillage. It is also called minimum tillage because it reduces the use of tillage to minimum enough to meet the requirements of crop growth. Thus tillage and sowing are combined in one operation. Reduced tillage is a conservation management
strategy that leaves at least 30% residue cover to minimize runoff and soil erosion, improve soil functions, and sustain crop production. This method reduces surface runoff by 35% and this reduced soil erosion by about 40%.

1.4.1.4 No tillage: In this type of operation, the soil is not disturbed much and it is left more or less undamaged. The crop is planted directly into the soil without any primary and secondary tillage operations. It is a practice that leaves all surface residues (stalks, cobs, leaves, etc.) on the soil following harvest. About 70% of soil erosion is reduced by this method.

1.4.1.5 Mulch tillage: It is a tillage practice where at least 30% of the soil surface remains covered with crop remains (mulches) after tillage. Tillage under this system is performed in such a way that it leaves or maintains crop remains on the soil surface. Mulch tillage is an extension of reduced tillage and is also called mulch farming or stubble mulch tillage. A minimum soil inversion takes place in this method. Mulches are useful in dissipating the energy of rainfall, they prevent splash and breaking of soil structure, hinder the runoff thereby reducing its velocity and prevent soil erosion.

1.4.1.6 Strip tillage: This type of tillage is an enhancement over no-tillage system. This system is also called partial-width tillage and consists of performing tillage in narrow isolated bands of about 0.2 m width and 0.1 m depth. It combines the benefits of no-till and tillage. The strips that will be used as seedbeds are only tilled. The strips between the tilled rows are left under no-till with under residue cover which is are known as loosening strips. Strip tillage loosens the tilled strip and temporarily improves drainage and reduces soil compaction. In the narrow strips, there are no stubbles which facilitates sowing and planting operation.

1.4.1.7 Buffer strips: Buffers are corridors of permanent vegetation used to reduce and control erosion. These conservation buffers are designed to decrease runoff and wind velocity and filter sediment particles. Buffer systems are commonly established between agricultural lands and water bodies (e.g., streams, rivers, lakes). When placed perpendicular to the direction of runoff and wind flow, buffers are effective measures for reducing sediment fluxes. They also facilitate the ponding of runoff thus improve infiltration of water. Riparian buffers, filter strips, grass barriers, grassed waterways, fields boarders and windbreaks are types of buffer strips.

1.4.2 Mechanical or Engineering measures of erosion control

Mechanical or engineering measures are used to control runoff and soil erosion in areas where agronomical control practices alone are insufficient to reduce soil erosion to permissible levels. These measures may be temporary or permanent in nature. Contour bunds, sand bags, silt fences, surface mats, and log barriers are temporary engineering measures of erosion control. Such Permanent measures include terraces, drop structures, spillways, culverts, gabions, ripraps, and ditches. The engineering measures are designed to intercept, store and reduce runoff velocity, convey runoff at non-erosive velocities, trap sediment and nutrients, protect the land
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from erosion, improve water quality, prevent flooding and reduce siltation of channels, streams and rivers. Some of the engineering measures of soil erosion control are discussed as under

1.4.2.1 Contour Bunds: It consist of constructing earth or stone embankments (bunds) of 1–2 m width on the field contours to reduce runoff velocity and conservation of rainwater. These bunds divide the field in approximately parallel segments for reducing effective slope length. Contour bunds are appropriate for areas with low rainfall and less permeable soils of gentle to moderate slopes. The sediment accumulated above bunds permits formation of natural terraces and enhances vegetation growth. They are not suitable for black cotton soils.

1.4.2.2 Graded Bunds: They are constructed in areas where the land is more vulnerable to water erosion, less permeable soils are present and waterlogging is a major problem. They are mainly designed to dispose-off excess runoff carefully from agricultural fields. They are provided with a longitudinal slope gradient leading to the outlet. This gradient is either uniform or variable. The uniform graded bunds are suitable for areas where the bunds need short length and the runoff is low. The variable graded bunds are suitable in areas where bunds need longer length hence runoff increases towards the outlet.

1.4.2.3 Terraces: Terraces are earthen embankments established across the slope dividing the field into uniform and parallel segments. These structures are often combined with channels to convey runoff to a main outlet at reduced velocities. The soil which is eroded by the runoff scour and raindrop splash flows down the slope and gets deposited up by the terraces. Terraces provide the greatest benefit to soil and water conservation when used in combination with: (1) proper cropping and tillage systems such as no-till, reduced tillage, residue mulching, crop rotation, contour strip cropping, and soil conservation buffers, and (2) other soil conservation structures such as grassed waterways, drainage channels, underground outlets, sediment control basins, drop structures, and gabions. Terraces are useful in slowing down the runoff velocity and reduce formation of peak runoff rates, reduction of the slope length of the hillsides by splitting the field into narrow bands, and reduction in soil erosion and concentrated runoff. They promote soil water storage by slowing and retaining runoff and promoting infiltration, reduce wind erosion by increasing soil water content and increasing surface roughness and facilitate surface irrigation in relatively level soils thus increasing crop production. Terraces are mainly classified into two types i.e. broad base terraces and bench terraces. Broad base terraces are again classified into two types i.e. graded (drainage channel type) and level (absorption or ridge type) terraces. Bench terraces are classified into four types i.e. Levelled (table top type), sloping inward type, sloping outward type and puertorican type terraces.

1.4.2.4 Grassed waterways: They are wide and shallow grassed channels under perennial grass established along the natural drainage pathways to convey runoff at low velocities and are appropriate for slopes up to 5%. They are often combined with drop structures established at various points within the waterways for reducing the slope. The width and length of grassed waterways depend on the drainage area and runoff volume. Geotextile mats and fast growing
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Grass species are used to ensure rapid protection of the channel in newly established grassed waterways. Grass waterways are also used to convey runoff from diversion systems, terraces, field outlets, and culverts along roads.

1.4.2.5 Silt Fences: Silt fences are filter barriers made up of woven and unwoven geotextile fabric products (e.g., jute, polyethylene) fastened to vertical metal or wooden posts, which are laid out on the contour across the slope for reducing runoff velocity and filtering the sediment. By reducing runoff velocity, the fences allow sediment deposition on the upslope side while enhancing runoff water infiltration.

1.4.2.6 Gabions: Gabions are permanent structures consisting of rocks and stones wrapped in metallic fences and stacked over one another. They are wire mesh boxes which are mostly cubical or cuboidal in shape. They are used for retaining walls, protecting culvert headwalls, stabilizing dams, dikes, and channels. These structures reduce gully erosion by reducing runoff velocity, by promoting sedimentation, and by reducing flow channelization. Concrete or rigid structures resist compressive forces but fail under high tensile loads unlike gabions. They are mostly used to control soil erosion caused due to action of torrents.

1.4.2.7 Drop spillway: It is a type of engineering structure which is also known as drop structure. They are suitable for controlling soil erosion at small drops of about 3-4 m of the gully bed. They are normally installed in series at regular intervals to stabilize a gully. These spillways are mainly of three types i.e. straight type, curved inlet type and box inlet type. Runoff flowing over the drop structure is released into a nearly flat apron before it is carried to a stable channel. The apron absorbs the energy of runoff and reduces its velocity. The rate of runoff passing over the structure is controlled by a box- or straight-inlet spillway with a depth between 0.5 and 1.5 m. The drop structure is appropriate for low fall heights and occupies less space than other structures and is constructed with concrete, rocks, lumber, or gabions. The drop structures are established at the gully head or at the lower end of gullies stabilized with grassed waterways. Well-designed and stable drop structures carry large volumes of runoff and their performance is not affected by clogging up with sediment and debris.

1.4.2.8 Chute spillway: Chute spillways are specifically designed to control overfalls within gullies and grassed waterways. These structures are constructed using cement concrete, gabions mattresses, rock ripraps, geotextile revetments, and wooden materials to transport concentrated runoff water down steep slopes and convey it at reduced velocities. The chute spillways absorb the energy of concentrated runoff through its sills and wing walls. Chutes are also used to carry runoff water from fields to ditches at low velocities, and their capacity is controlled by the upslope inlet size. They are suitable for a drop height of 6 m or more. These structures are appropriate for slopes up to 25%. These spillways require less construction material than ordinary straight drop structures, hence they are cheaper and economical. Chute spillways cannot be used for storage of water.
1.4.2.9 Pipe spillway: It is also known as drop inlet spillway. These structures are designed for high drops of water runoff. Pipes consist of corrugated plastic and metal pipes with various forms of inlet and outlets. The inlet may be straight type, upstream flared type or flared type. A temporary runoff storage area is required before releasing runoff through the pipes. The area around inlet and outlets must be lined with concrete or stones and/or compacted material and maintained clean. A pipe spillway is designed from earthen dam constructed across gullies with a corrugated pipe. Water released from pipes is used in ponds and sediment basins.

These are some of the biological and engineering measures of erosion control. If adopted properly and applied scientifically, they may be very much useful in controlling and checking soil erosion to a great extent.

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EFFECTS OF SIMULATED ACID RAIN ON PLANT, GROWTH COMPONENTS OF GREEN GRAM (VIGNA RADIATA LINN WILLZECK CV K 851) AND BANKLA (VICIA FABA LINN CV ALL GREEN)

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ABSTRACT

The present study has been undertaken to study the effects of Simulated Acid Rain on two important food crops grown widely in India. Most of the investigations on the effects of acid precipitation made so far are based on local vegetation. The main objective is to characterize a relative growth and yield response of these leguminous crops to different concentration of simulated acid rain.

The legumes are important food crops for human beings as they are good source of protein, carbohydrate and fats. This research studied the effect of Simulated Acid Rain on plants, growth components of Green Gram and Bankla. Green Gram [Moong Vigna radiata linn willzeck cvk 851 and Bankla Vicia faba Linn cv all green (Broad bean)] are belong to Leguminaceae sub family Papilionaceae.

Simulated Acid Rain was prepared with different concentrations of H$_2$SO$_4$ and HNO$_3$ in the ratio 7:3. The plants were exposed to simulated acid rain of pH 2.5, 3.5, 4.5 and 5.5 with control. The morphological changes including plant height, days and time taken in flowering (No, of days), number of leaves were recorded. All the morphological parameters taken in this study showed decrease trend with decrease pH (increase in acidity). The yield of Moong and Bankla decreased due to acidic rain.

INTRODUCTION

Robert Angus Smith (1872) was first who used the term Acid Rain over 100 years ago in describing his studies of air pollution in and around Manchester. Acid Rain was first detected in England, but now Acid Rains problem has been reported not only in America, Europe and England but also from Metro Cities in India like Kanpur, Agra, Mumbai, Kolkata and Delhi. Simulated Acid Rain had been shown destroying effects on plants in pH below 3.5, since plant foliage is affected by pH levels below 3.4. Jonsson and Sundberg (1972),

Acid rain is wet deposition that has been acidified when pollutants such as oxides of sulphur and nitrogen contained in power plants emission, factory smoke and car exhaust react with moisture present in the atmosphere (Kita et al. 2004). In natural conditions, atmospheric precipitation is slightly acidic due to dissolution of atmospheric carbon dioxide (Nduka et al. 2008). pH value lowers than 5.6 is considered acid deposition and may cause decline in health and growth of plants (Liu et al. 2010)

Acid rain exposure of plants result in a characteristic foliar injury, symptoms modified leaf anatomy (Stoynora and Nelikova 1998, Park and Yanai 2009). Reduction in plant growth and yield in the field of Corn (Banwart et al. 1988), Green Pepper (Shirpal et al. 2000) and Tomato (Fursun et al. 2002) were reported. Acid Rain also have negative effect on growth and productivity of forest tree and crop plants. Many anthropogenic sources also tend to acidify rain water (Horner and Bell 1995)
MATERIAL AND METHODS

Plant Material
The experiments were conducted on Moong Vigna radiata linn willzeck cvk 851 and Bankla Vicia faba Linn cv all green (Broad bean) variety was used for this experiment.

Preparation of Acid Water Solution
Acid solutions of pH 2.5, 3.5, 4.5, 5.5 were prepared by adding a mixture of H$_2$SO$_4$ (98% pure) and HNO$_3$ (69.71% pure) in the ratio of 7:3 v/v in distilled water Lee et al. (1981). The pH was adjusted with the help of a pH meter. A Solution once prepared was used only for four treatments and after that fresh solutions were prepared for further use.

For Long Term Exposure Experiments
For long term exposure experiments seeds were sown in pots with a diameter of 50 cm. Each pot contained about 4 kg of garden soil which was well pulverized and homogenized with farm manure. Five seeds were sown in each pot but after the emergence of seedling thinning were done and only one healthy plant was left per pot. During the course of experiment plants were watered on alternate days in the evening.

Plants were exposed to simulated acid rain water solution. It was given at an interval of 10 days with the help of one liter hand held plant sprayer. For each cultivar there were five sets of plants with 10 plants in each set. of these five sets, four sets were sprayed with acid water solution of 2.5,3.5,4.5,5.5 pH while fifth set, which served as control was sprayed with water.

Growth Responses
Height of plant
Number of leaves per plant
Number of branches per plant

Yield Parameters
Days of flowering
Number of flowers per plant
Number of pods per plant
Days to first pod maturation
Number of seed per pod

RESULTS AND DISCUSSION
After two months, both legumes Moong Vigna radiata linn willzeck cvk 851 and Bankla Vicia faba Linn cv all green (Broad bean) experimental data were collected for each group crop under treatment and various observation were recorded (Fig. 1a, 1b)

In Vicia faba Linn cv all green (Broad Bean) and Vigna radiata linn willzeck cvk 851, a more less similar results were obtained in the plants treated with simulated acid rain of pH 5.5, 4.5, 3.5 and 2.5. The maximum height of plant, number of leaves and branches observed in plants treated with simulated acid rain of pH 5.5. The maximum Number of flowers and pods per plant and seeds per pod was also observed in the plants treated with simulated acid rain of pH 5.5. The
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lowest growth parameters i.e. height of the plant, number of leaves and branches per plant were observed in the plants treated with simulated acid rain of pH 2.5 (Table 1 and Table 2)

Various growth attributes observed at different ages of plants were remarkably reduced at pH levels of 3.5 and 2.5. The changes were less at pH 4.5 and pH 5.5. Ashenden and Bell (1989) and others reported that adverse effects occur only in response to rainfall acidity below pH 3.0. As the age of crop increased the degree of susceptibility also increased. This evidenced by increase in adverse effects caused by simulated acid rain. Growth and productivity inhibition in different crops have also been reported (Kumar 1997, Shripal and Kumar 2000, Katiyar and Dubey 2000 and Gadallah 2000)

A possible reason for decrease in photosynthesis is that acid rain causes extensive injury to photosynthetic apparatus thus reducing the chlorophyll contents (Ciu and Liu 2000, Wareing et al 1968) and another reason for growth reduction. According to them acidification of cytoplasm may reduce auxin levels in the leaves and cytokine levels in roots which in turn could lower photosynthesis. A gradual decrease in the plant height and number of branches were recorded with increased acidity. This decrease is related with reduced shoot length and less number of branches may be due to reduced photosynthesis. Significant reduction in the number of leaves per plant below pH 4.5 were also recorded during the present study. Several worker have also observed similar reduction in the number of leaves (Bell and Clough 1973; Evans and Levin 1981, Verma 1999)

Figure 1a and 1b showing effect of simulated acid rain of pH 2.5, 3.5, 4.5, 5.5 on (a) vicia faba (b) vigna radita
### Different Concentration of Simulated Acid Rain on Vegetative and Productivity Parameters Table 1

**Vicia faba Linn (bankla)**

<table>
<thead>
<tr>
<th>Treatment in Acid Rain pH</th>
<th>Height in Cm.</th>
<th>No. of Branches</th>
<th>No. of Leaves</th>
<th>No. of Day of flowering</th>
<th>No. of Flower</th>
<th>No. of Pod</th>
<th>No. of Seed Per Pod</th>
<th>No. of Days First pod ripe</th>
<th>Nodulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bankla</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Control</td>
<td>54.5</td>
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<td>91.2</td>
<td>96.2</td>
<td>7.2</td>
<td>8.1</td>
<td>-3.6</td>
<td>125.3</td>
<td>+</td>
</tr>
<tr>
<td>2.5</td>
<td>41.5</td>
<td>2.1</td>
<td>96.5</td>
<td>88.2</td>
<td>12.5</td>
<td>6.2</td>
<td>-3.1</td>
<td>121.5</td>
<td>-</td>
</tr>
<tr>
<td>3.5</td>
<td>42.5</td>
<td>2.5</td>
<td>98.8</td>
<td>90.5</td>
<td>13.6</td>
<td>7.1</td>
<td>-3.3</td>
<td>122.2</td>
<td>+</td>
</tr>
<tr>
<td>4.5</td>
<td>44.2</td>
<td>3.4</td>
<td>100.2</td>
<td>91.7</td>
<td>15.6</td>
<td>8.3</td>
<td>-3.4</td>
<td>123.5</td>
<td>++</td>
</tr>
<tr>
<td>5.5</td>
<td>44.5</td>
<td>4.2</td>
<td>115.2</td>
<td>92.3</td>
<td>16.2</td>
<td>9.4</td>
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<td>124.2</td>
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<td>CD 5%</td>
<td>1.963</td>
<td>0.187</td>
<td>3.002</td>
<td>3.923</td>
<td>0.400</td>
<td>0.223</td>
<td>0.131</td>
<td>4.738</td>
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<tr>
<td>CD 1%</td>
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<td>0.253</td>
<td>4.054</td>
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<td>0.540</td>
<td>0.310</td>
<td>0.177</td>
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CD= critical differences
Significant at 5% Significant at 1% The date based on 4 samples of each treatment

<table>
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<th>Below Normal</th>
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<tr>
<td></td>
<td>++</td>
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<td></td>
<td>+++</td>
<td>Heavy</td>
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<td></td>
<td>-</td>
<td>No Nodulation</td>
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</table>

### Different Concentration of Simulated Acid Rain on Vegetative and Productivity Parameters Table 2

**Vigna radiata (Linn) Willczeck (MOONG)**

<table>
<thead>
<tr>
<th>Treatment in Acid Rain Ph</th>
<th>Height in Cm.</th>
<th>No. of Branches</th>
<th>No. of Leaves</th>
<th>No. of Day of flowering</th>
<th>No. of Flower</th>
<th>No. of Pods</th>
<th>No. of Seed Per Pod</th>
<th>No. of Days First pod ripe</th>
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<td>59.2</td>
<td>11.3</td>
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<td>-7.5</td>
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<td>2.5</td>
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<td>2.7</td>
<td>21.2</td>
<td>54.3</td>
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<td>-5.8</td>
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<td>55.2</td>
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<td>56.1</td>
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<td>76.5</td>
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<tr>
<td>5.5</td>
<td>31.5</td>
<td>3.4</td>
<td>24.6</td>
<td>56.6</td>
<td>10.5</td>
<td>8.8</td>
<td>-7.2</td>
<td>76.1</td>
<td>++</td>
</tr>
<tr>
<td>CD 5%</td>
<td>1.52</td>
<td>0.136</td>
<td>0.830</td>
<td>1.613</td>
<td>0.435</td>
<td>0.276</td>
<td>0.236</td>
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<tr>
<td>CD 1%</td>
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<td>0.184</td>
<td>1.121</td>
<td>2.178</td>
<td>0.583</td>
<td>0.372</td>
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CD= critical differences
Significant at 5% Significant at 1% The date based on 4 samples of each treatment

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<td>++</td>
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<tr>
<td></td>
<td>+++</td>
<td>Heavy</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>No Nodulation</td>
</tr>
</tbody>
</table>
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PLATE-1

Showing growth and productivity parameters (pH)

A-  Height in CM.

B-  No. of Branches

B-  No. of Leaves

D-  No. of Days of Flowering

Moong
Bankla

Moong
Bankla

Moong
Bankla

Moong
Bankla
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E- No. of Flowers

<table>
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<tr>
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<th>3.5</th>
<th>4.5</th>
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<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
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<td>7</td>
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<td>5</td>
<td>4</td>
<td>3</td>
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</table>

F- No. of Pods

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<td>120</td>
<td>100</td>
<td>80</td>
<td>60</td>
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<tr>
<td>Bankla</td>
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<td>100</td>
<td>80</td>
<td>60</td>
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G - No. of Seeds per Pod

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<tbody>
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<td>100</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>Bankla</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
<td>50</td>
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H- No. of Days first pod ripe

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<th>4.5</th>
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<tr>
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<td>100</td>
<td>80</td>
<td>60</td>
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<td>Bankla</td>
<td>100</td>
<td>80</td>
<td>60</td>
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Conclusion
The present investigation embodies the work on two economically legumes Moong *Vigna radiata linn willzeck* cvk 851 and Bankla *Vicia faba Linn* cv all green (Broad bean). All the two crops were treated with Simulated Acid Rain of pH 2.5, 3.5, 4.5 and 5.5. The vegetative parameters and yield showed marked reduction in pH 2.5 and 3.5 and at pH 5.5, the effect was relatively less. The productivity in crops decreased with increased in acidity. Significant reduction in nodule formation in crops with increase in pH had also been observed during the study.

REFERENCE


Kumar V. (1997)- Effect of simulated acid rain on zea mays L. Phd Theses C.C.S. University Meerut Uttar Pradesh.