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Causes and impact of farmers' suicide in India

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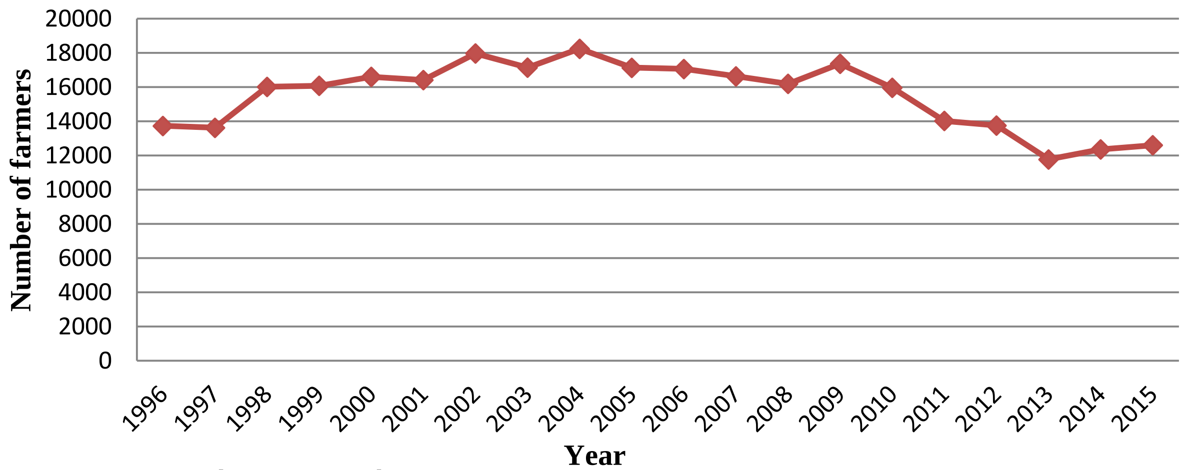
Agriculture is the backbone of Indian economy. It plays a vital role in the economic growth and development of the county. Out of the total population of India, more than 55 per cent of people is engaged in agriculture. Nowadays secondary and tertiary sector are growing rabid rate but in the case of agriculture, the ultimate producer committing suicide every year due to the several cumulative causes- bankruptcy, family problem, farming problem and relates issue, illness, addiction to a drug. In 2015, National Crime Records Bureau reported that total 12,604 people (8007 farmers and 4595 agricultural laborers) committed suicide in the farming sector.

Farmers' suicide report NCRB 1995- 2015



Source: National Crime Records Bureau

This report reveals that most of the farmers committed suicide in Maharastra followed by Karnataka, Telangana, Madhya Pradesh, Chattisgarh, Andra Pradesh and Tamil Nadu. The United Nations Commission on Sustainable Development (UNCSD) reported about one farmer committing suicide every 32 minutes between 1997 and 2005 in India. According to this situation, India formulated different policy strategies and scheme to control the farmers' suicide and to promote the socio-economic condition for farmers. The graph revealed that average of 15305 farmers committing every year in the farming sector for several reasons.

CAUSES OF FARMERS' SUICIDE

The farmers who committed suicide cannot be attributed by a single reason; there are several reasons under which make them commit suicide. These reasons are classified two main categories 1.Nature and farm-related issue, 2.Social-economic condition of farmers

1. Nature and farm-related issue:

1) Even today, in several parts of India, agriculture is a seasonal occupation. In many districts, farmers get only one crop per year and for the remaining part of the year farmer kept a fallow land, and they find it difficult to make both ends meet. In India, rainfed agriculture occupies nearly 58 per cent of the cultivated area. Nowadays the irrigation facilities do not cover the entire cultivable land. Any failure of nature directly affects the fortunes of the farmers.
2) The economic status of farmer mainly determines the land holding capacity. In case of small and marginal farmers, the operation holding of land size very small which makes profitable cultivation impossible because a significant portion of the earnings go towards the payment of lease for the land.
3) Weather phenomena- India fully diversified in soil and climatic condition. We have advanced technology to predict the weather but some uncertainty case the prediction will go wrong. At one time, there will be no rainfall and farmer have to suffer drought and next year same season heavy rainfall and crop will be damaged.
4) Basically, Indian agriculture is unorganized sector; there is no systematic cultivation and planning in crop production. Ultimately it may occur the yield and profit of farmers.
5) Raising input price-The cost of agriculture inputs have been steadily increasing over the years, farmers' margins of profit reducing because the price rise in the input is not complemented by an increase in the purchase price of the agricultural produce.
6) Cropping pattern-most of the farm profit depends on cropping pattern and cultivation practices. But in the cause most number of farmers is illiterate, they are lacked in knowledge about weather phenomenon, harvesting practices, seed sowing methods, and crop processing.

2. Social-economic condition of farmer

1) Indebtedness -The root cause of farmers' suicide is the increasing in Indebtedness and dept burden of farmers. Farmers borrowed money from two different resources like the institutional loan and non-institutional loan. Number of Suicides committed due to institutional loan has been stated in Karnataka , Tamil Nadu, Maharashtra, Kerala and West Bengal ,whereas non-institutional loan in Punjab, Karnataka, West Bengal, Telangana. According to NCRB report major causes of suicides among farmers due to the indebtedness and farming related issues are at rate of 38.7per cent (3,097 out of 8,007 suicides) and 19.5

per cent (1,562 out of 8,007 suicides) of total such suicides respectively during 2015.

2) High interest rate – most of small and marginal farmers are not aware about the institutional loan, they always borrowed money from local money lenders with high interest rate. Exorbitant interest rates have to be declared illegal and the government has to take strict measures against greedy money lenders.
3) Family Problems-The other most important causes of farmer suicides were family problems (933 suicides), illness (842 suicides) and drug abuse/alcoholic addiction (330 suicides), accounting for 11.7 per cent, 10.5 per cent and 4.1 per cent of total farmers suicides respectively (source; NCRB-2015).
4) Government programme do not reach small farmer. However, most of the subsidies and welfare schemes announced by the Central and State governments do not reach the poor farmers. On the contrary, only big land lords are benefited by those schemes like minimum purchase prices of the government do not in reality reach the poorest farmer.

3. Impact of farmers' suicide;

1) Land sold- Farmer suicide; an all in India study report revealed that farmer's death it's severely affected the households and family economic condition. So the families sold land to the private money lenders for run the household and family. Discontinuation of agriculture was another impact as seen in the case of farmer suicide.
2) Insecurity and depression-Insecurity in the family and family members under depression were among the major impacts opined by farmers' households in the study. Insecurity in the family was opined majorly in Tamil Nadu, West Bengal and Telangana.
3) Discontinued the education- Farmer suicide; an all in India study says that large number of farmer households had discontinued their children's education. It majorly noted in the state Madhya Pradesh, Tamil Nadu and Gujarat.
4) Real estate mafia- The real estate peoples are purchased the agriculture fertile land make plots give attractive advertisements to sell at the exorbitant price.

CONCLUSION

There cannot be single solution to end the woes of farmers. A giving monetary relief is not an effective solution. The solutions should aim at the entire structure of agriculture. The Government needs to come up with pro-active solutions and the nation has to realize that farmers' suicides are not minor issues happening in remote parts of a few states, it is a reflection of the true state of the basis of our economy.

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Hydroponics: The soilless culture of plants

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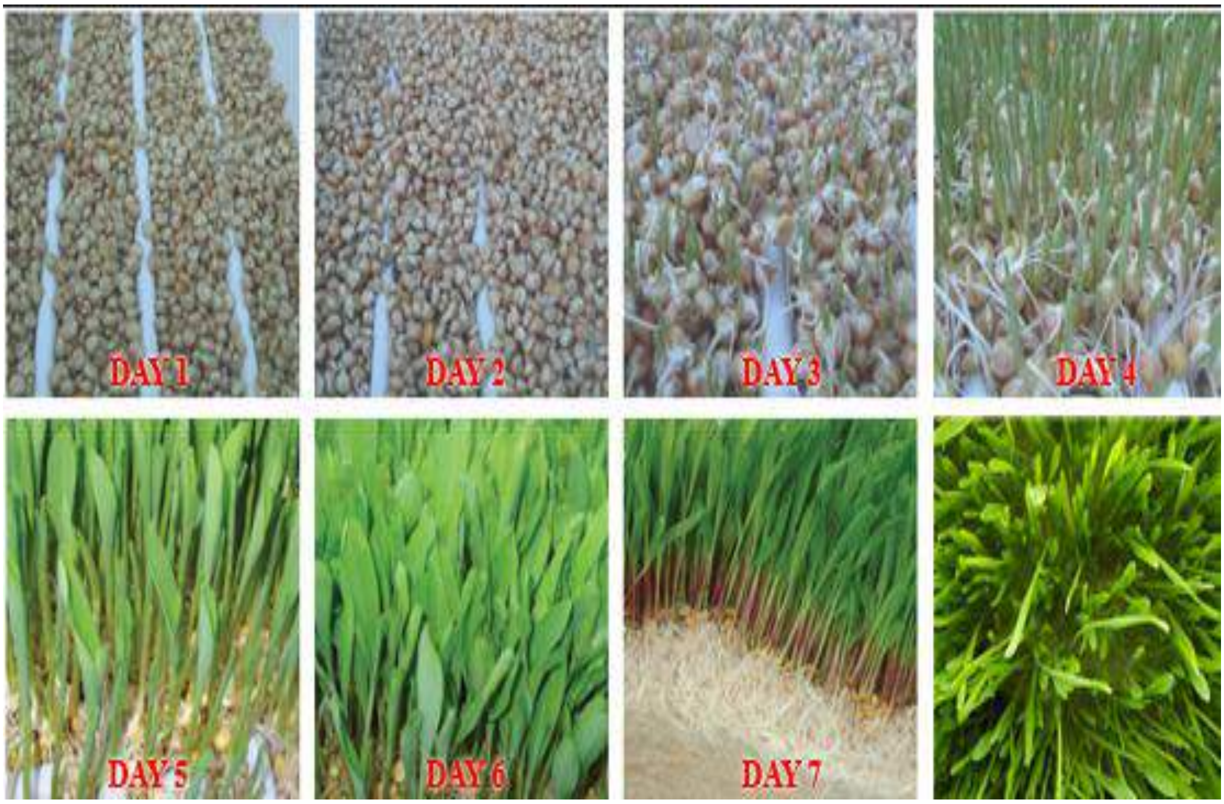
Hydroponics is the science of growing plants without the use of soil, using mineral nutrient solutions in a water solvent. Roots may be supported by an inert medium, such as gravel, sand, peat, vermiculite, pumice or sawdust to which nutrient solution containing all the essential elements needed by the plants for its normal growth and development are added. The nutrients in hydroponics can come from an array of different sources like byproduct from fish waste, duck manure, or normal nutrients.

The earliest published work on growing terrestrial plants without soil was the 1627 book Sylva Sylvarum or A Natural History by Francis Bacon, printed a year after his death. In 1699, John Woodward published his water culture experiments with spearmint. He found that plants in less-pure water sources grew better than plants in distilled water. By 1842, a list of nine elements believed to be essential for plant growth had been compiled, and the discoveries of German botanists Julius von Sachs and Wilhelm Knop, in the years 1859–1875, resulted in a development of the technique of soilless cultivation. Growth of terrestrial plants without soil in mineral nutrient solutions was called solution culture. In 1929, William Frederick Gericke of the University of California at Berkeley began publicly promoting that solution culture be used for agricultural crop production. Gericke grew tomato vines twenty-five feet (7.6 metres) high in his back yard in mineral nutrient solutions rather than soil. He introduced the term hydroponics, water culture, in 1937, proposed to him by W. A. Setchell, a phycologist. Hydroponics is derived from neologism ,constructed in analogy to geoponica, that which concerns agriculture, replacing, earth, with water.

Hydroponic growing systems produce a greater yield over a shorter period of time in a smaller area than traditionally-grown crops. There is a reduction or exclusion of pesticides and herbicides because the plants are in a more protected growing environment. Hydroponics is a year-round growing system that produces a consistent quantity and quality of plant material, regardless of outside weather. Fodder (livestock feed) can be grown hydroponically much the same as vegetables, flowers, and other plants. Hydroponic fodder systems are usually used to sprout cereal grains, such as barley, oats, wheat, sorghum, and corn, or legumes, such as alfalfa, clover, or cow peas.

Barley is the most commonly grown forage, because it usually gives the best yield of nutrients. Only moisture and nutrients are provided to the growing plants.

A hydroponic fodder system usually consists of a framework of shelves on which metal or plastic trays are stacked. After soaking overnight, a layer of seeds is spread over the base of the trays. During the growing period, the seeds are kept moist, but not saturated. They are supplied with moisture and (sometimes) nutrients, usually via drip or spray irrigation. Holes in the trays facilitate drainage and the waste water is collected in a tank. The seeds will usually sprout within 24 hours and in 5 to 8 days have produced a 6 to 8 inch high grass mat. After the mat is removed from the tray, it can go into a feed mixer or be hand-fed to livestock. Livestock will eat the whole thing: seeds, roots, and grass. There is minimal waste. Livestock may not eat the fodder initially because it is novel, but should soon learn to eat it with relish.



ADVANTAGES OF HYDROPONIC FODDER

1. Crops can be grown where no suitable soil exists or where the soil is contaminated with diseases.
2. Hydroponic fodder makes very efficient use of water and there is no leaching of nutrients into the environment. This can lead to a reduction in pollution of land and streams because valuable chemicals need not be lost.
3. Hydroponic fodder production is probably best-suited to semi-arid, arid, and drought-prone regions of the world. By growing fodder indoors, crop failures would no longer be a risk. Good quality forage could be produced year-round.

4. Hydroponic fodder production requires considerably less land to produce feed for livestock. In places where land values are extremely high or land is simply not readily available, hydroponic fodder has obvious advantages, as it can be produced in a small footprint. Because the fodder is produced continuously, there is no need for long-term feed storage and no nutrient losses that can be associated with feed storage
5. More complete control of the environment is generally a feature of the system i.e root environment, timely nutrient feeding or irrigation and in greenhouse type operations , the light, temperature, humidity, and composition of the air can be manipulated.

DISADVANTAGES

1. The construction cost per acre is great
2. Moldy sprouts can decrease animal performance and result in animal death hence, trained personnel must direct the growing operation.
3. Time is needed to soak the seed, make up the nutrient solution, transfer the grain to the trays, load the trays onto the shelves, check the fodder daily for growth, remove the sprouted grain from the trays, wash and sterilize the trays, and feed the fodder to the livestock.
4. The reaction of the plant to good or poor nutrition is fast. The grower must observe the plants every day.

CONCLUSION

In the future As competition for land and water increases and feed prices continue to rise, hydroponics fodder could become a viable option for more livestock producers.

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Trap crops: A valuable tool in organic pest management

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Abstract

Crops that are grown to attract insects or other organisms like nematodes to protect target crops from pest attack. Trap crops provide many benefits, including increasing crop quality, attracting beneficial insects, enhancing biodiversity and reducing insecticide use. Trap crops can be planted around field perimeters or inter-planted with the cash crop. Trap cropping also has a tremendous potential to control other crop pests.

Keywords: Trap crops, crop quality, beneficial insects, biodiversity

INTRODUCTION

The concept of trap cropping fits into the ecological framework of habitat manipulation of an agroecosystem for the purpose of pest management. Many different methods alter the habitat as part of an integrated pest management (IPM) strategy, and such manipulation can occur at the within-crop, within-farm, or landscape level. The basic principle of trap cropping is that insects have preference for host plants and will move to a preferred host if given a choice. Insects are highly attracted to reproductive stages of host plant over the vegetative stages and trap cropping uses this attraction to good use. Generally, the trap crop is considered 'sacrificial' because it protects the valuable main crop when pest populations exceed normal levels.

Trap cropping

Trap cropping is the planting of a trap crop to protect the main cash crop from a certain pest or several pests. The trap crop can be from the same or different family group, than that of the main crop, as long as it is more attractive to the pest. There are two types of planting the trap crops; perimeter trap cropping and row intercropping. Perimeter trap cropping (border trap cropping) is the planting of trap crop completely surrounding the main cash crop. It prevents a pest attack that comes from all sides of the field. It works best on pests that are found near the borderline of the farm. Row intercropping is the planting of the trap crop in alternating rows within the main crop. The trap crops need to be sown at least 1 m away from the main crop to avoid shading

ADVANTAGES OF TRAP CROPPING

Trap cropping offers several benefits in a pest management system. When trap crops successfully attract pest populations, damage to the main crops is limited; therefore, main crops seldom require treatment with insecticides. When insect pests are at high concentrations in trap crops, they can be treated in a localized area instead of treating the entire field. Savings resulting from reduced pest attack and insecticide use may substantially outweigh the cost of maintaining crops that do not provide economic income. Reduced damage to main crops also increases their expected marketable yield. Further, a variety of plantings and increased concentration of insect pests may attract natural enemies, enhancing naturally occurring biocontrol**.**

- Lessens the use of pesticide and lowers the pesticide cost
- Preserves the indigenous natural enemies
- Improves the crop's quality
- Helps conserve the soil and the environment
- Reduce damage to cash crops
- Attract beneficial organisms
- Decrease the use of external inputs (e.g., insecticides, herbicides, fungicides)
- Enhance biodiversity
- Increase productivity

MODALITIES OF TRAP CROPPING

The main modalities of trap cropping can be conveniently classified according to the plant characteristics or how the plants are deployed in space or time. Other modalities, such as biological control–assisted and semiochemically assisted trap cropping, may not easily lend themselves to such dichotomous classifications but can provide important contributions to trap cropping.

Based on the trap crop plant characteristics:

Conventional trap cropping, we use this term to define the most general practice of trap cropping, in which a trap crop planted next to a higher value crop is naturally more attractive to a pest as either a food source or ovi position site than is the main crop, thus preventing or making less likely the arrival of the pest to the main crop and/or concentrating it in the trap crop where it can be economically destroyed. This modality was the primary focus of the two previous reviews. One of the most widely cited examples of successful conventional trap cropping, which served as a major contributor to the development of IPM in the central valley of California in the 1960s, is the use of alfalfa as a trap crop for lygus bugs in cotton (Godfrey & Leigh, 1994). Ex: Castor and Marigold in Ground nut crop

Dead end Trap cropping- Trap crops which are highly attractive to insects but they or their offspring's can't survive. Dead-end trap crops serve as a sink for pests, preventing their movement from the trap crop to the main crop later in the season Ex: Indian mustered for Cabbage diamond back moth, Sun hemp for Bean pod borer.

Genetically engineered trap cropping- Crops are genetically modified (i.e., the deliberate manipulation of genes through the use of biotechnology) to attract pests. For example, potatoes that have been genetically engineered to express proteins from *Bacillus thuringiensis* (Bt) have been used as trap crops to manage Colorado potato beetle populations. If Bt potatoes are planted early in the season to attract immigrating Colorado potato beetle, they can act as an early season, dead-end trap crop and prevent colonization of the interior of the field that is planted to non-Bt potatoes (Hoy, 1999).

Based on the deployment of the trap crop:

Trap cropping should be viewed in the larger context of landscape ecology. From the standpoint of trap cropping, the most relevant parameters of the land scape structure are those that refer to the spatial pattern of vegetation patches, including their distribution, size, shape, configuration, number, and type. Insects and their host plants interact and become influenced by size, fragmentation, and connectivity of host patches (Tscharntke & Brandl, 2004).

Perimeter trap cropping, perimeter trap cropping can be defined as the use of a trap crop planted around the border of the main crop. The use of field margin manipulation for insect control is becoming common in IPM programs and is similar in practice to the early use of traditional trap cropping using borders of more attractive plants (Boucher *et al*., 2003).

Fig.1. Castor as a trap crop in the field

Sequential trap cropping, this modality involves trap crops that are planted earlier and/or later than the main crop to enhance the attractiveness of the trap crop to the targeted insect pest. An example of this is the use of an early-season trap crop of potatoes to manage Colorado potato beetles, which we described also as a perimeter trap cropping example (Hoy *et al*., 2000).

Multiple trap cropping, multiple trap cropping involves planting several plant species simultaneously as trap crops with the purpose of either managing several insect pests at the same time or enhancing the control of one insect pest by combining plants whose growth stages enhance attractiveness to the pest at different times. All the multiple trap cropping cases that we found in the literature belong to the latter category. For example, a mixture of Chinese cabbage, marigolds, rapes, and sunflower has been successfully used as a trap crop for the pollen beetle, in cauliflower fields in Finland.

Push-pull trap cropping, push-pull or "stimulo-deterrent diversion" strategy is based on a combination of a trap crop (pull component)with a repellent intercrop (push component). The trap crop attracts the insect pest and, combined with the repellent intercrop, diverts the insect pest away from the main crop. Ex. Marigold and Onion in Chilli. A push-pull strategy based on using either Napier or Sudan grass as a trap crop planted around the main crop, and either Desmodium or Molasses grass planted within the field as a repellent intercrop, has greatly increased the effectiveness of trap cropping for stem borers.

Additional trap cropping modalities

Biological control-assisted trap cropping, our definition of trap cropping focuses on the interactions between the plant and the pest rather than on the natural enemies of the insect pest. We chose this delineation to preserve the distinction between habitat manipulation for enhanced biological control and the various examples of what we suggest constitute trap cropping (Landis *et al*., 2000).

Semiochemically assisted trap cropping, principles underlying the effects of trap cropping on insect behavior are similar to those behind semiochemicals and other behavior-based methods for pest management. In conventional trap cropping, attraction to the plant may be due to semio chemicals naturally produced by the trap crop. Semiochemically assisted trap crops are either trap crops whose attractiveness is enhanced by the application of semiochemicals or regular crops that can act as trap crops after the application of semiochemicals. One of the most successful examples of this trap crop modality is the use of pheromone-baited trees that attract bark beetles to facilitate their control (Borden & Greenwood, 2000).

System of planting some trap crop: - Ex.

- Planting Indian mustard as a trap crop for management of Diamond Back Moth. Sowing of two rows of bold seeded Mustard in every 25 rows of Cauliflower/Cabbage.
- Planting Cow pea as intercrop for management of *Heliothis* sp. Sowing of one rows of Cow pea in every 5 rows of cotton.
- Planting Tobacco as trap crop for management of *Heliothis* sp. Sowing of two rows of Tobacco in every 20 rows of Cotton.
- Planting African marigold as trap crop for management of Fruit borer. Sowing of two rows of marigold in every 14 rows of Tomato.

- Planting Coriander or Fenugreek as trap crop for management of shoot and fruit borer. Sowing of one rows of Coriander or Fenugreek in every two rows of Brinjal.
- Planting Coriander or Marigold as a trap crop for management of Gram pod borer. Sowing of one rows of Coriander or Marigold in every 4 rows of Gram.
- Planting Corn as trap crop for management of *Heliothis* sp. Sowing of two rows of Tobacco in every 20 rows of Cotton.

Table 1. Examples of trap cropping practices

Trap crop	Main crop	Method of planting	Pest controlled
Alfalfa	Cotton	Strip intercrop	Lygus bug
Basil and marigold	Garlic	Border crops	Thrips
Castor plant	Cotton	Border crop	*Heliotis sp.*
Chervil	Vegetables Ornamentals	Among plants	Slugs
Chinese cabbage, mustard, and radish	Cabbage	Planted in every 15 rows of cabbage	Cabbage webworm Flea hopper Mustard aphid
Beans and other legumes	Corn	Row intercrop	Leafhopper Leaf beetles Stalk borer Fall armyworm
Chick pea	Cotton	Block trap crop at 20 plants/ sq m (Brown, 2002)	*Heliotis sp.*
Collards	Cabbage	Border crop	Diamondback moth
Corn	Cotton	Row intercrop, planted in every 20 rows of cotton or every 10-15 m	*Heliotis sp.*
Cowpea	Cotton	Row intercrop in every 5 rows of cotton	*Heliotis sp.*
Desmodium	Corn, Cowpea Millet, Sorghum	Row intercrop	Stemborer Striga
Dill and lovage	Tomato	Row intercrop	Tomato hornworm
Green beans	Soybean	Row intercrop	Mexican bean beetle
Horse radish	Potato	Intercrop	Colorado potato

			beetle
Hot cherry pepper	Bell pepper	Border crop	Pepper maggot
Indian mustard	Cabbage	Strip intercrop in between cabbage plots	Cabbage head caterpillar
Marigold (French and African marigold)	Solanaceous Crucifers Legumes Cucurbits	Row/strip intercrop	Nematodes
Medic, *Medicago litoralis*	Carrot	Strip intercrop in between carrot plots	Carrot root fly
Napier grass	Corn	Intercrop Border crop	Stemborer
Nasturtium	Cabbage	Row intercrop	Aphids Flea beetle Cucumber beetle Squash vine borer
Okra	Cotton	Border crop	Flower cotton weevil
Onion and garlic	Carrot	Border crops or barrier crops in between plots	Carrot root fly Thrips

CONCLUSION

If the right trap crops can be found and applied correctly, it could lead to ecologically and environmentally sustainable management techniques that could be considered in future agricultural ecosystems. Trap crops should be sown earlier or on the same day as the commercial crop, so that the flowering or fruit set will coincide with the commercial crop fruit development. Trap cropping will be act as an effective tool in controlling pests under organic farming.

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Cannibalism: A threat to poultry industry

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Cannibalistic behaviour is considered serious welfare and economic problems to poultry producer's worldwide. Cannibalistic is a natural expression of dominance in poultry flocks.Chickens and turkeys normally feed on grains, vegetation and meat but under certain conditions they may become meat eaters to the extent of being cannibalistic. Dominant birds will peck the submissive members of the flock or its cage mates. Unfortunately, cannibalism can also be a learned behaviour and is enhanced by the flock observing other birds engaging in same behaviour. Once blood has been drawn from a bird, its pen mates literally see red and they go on picking blood and meat from the victim. Unless, the picked bird is removed or treated, the picked bird will be prone to death. Cannibalism once started is a vicious habit. Cannibalistic behaviour occurs throughout the animal kingdom in wild and captive populations. In the wild, the adaptive function increases an individual's fitness by providing nutrients and reducing competition for resources (Denniset *al*., 2009).

In captive situations, it is perceived as an abnormal behaviour and its underlying causes are poorly understood. Cannibalism is one of the main causes of mortality in laying hens. Often a very aggressive hen will kill its entire cage mates until it is the only one left. The prevalence of cannibalism varies from flock to flock and season to season. In some extreme cases high mortality has been observed. Even in cases where the mortality is kept at a low level, losses in market value may occur. Cannibalism in fowl is a costly and vicious habit that poultry producers can not afford to ignore. It may occur at any age among all breeds, strains and sexes of fowl. Cannibalism usually occurs when the birds are stressed by a poor management practice. Once becoming stressed, one bird begins picking the feathers, comb, toes or vent of another bird. Bruises and torn skin and scabs in picked areas also result from this vice (Austic *et al.,* 1979).

TYPE OF PECKING/ CANNIBALISM

The types of pecking in poultry are described below.

Toe Pecking

Toe pecking is sometimes widespread amongst young chicks and is often the result of inadequate feeder space or the inability of the chick to find feed. The active chick will peck at its neighbour's toes and sometimes even its own toes. While toe picking may not lead to significant injury in chicks, it can cause major injury in adult birds (Cloutier *et al.,* 2002).

Feather Pecking

This is a habit forming trait that can be instilled in other birds, resulting in the entire flock becoming affected. It can be common in caged flocks or those kept in close confinement, resulting in the lack of sufficient exercise. Feather pecking resembles feed pecking, which is usually directed towards the head of the bird. Feather "licking" causes no apparent damage to the feathers and is considered normal exploratory behaviour. Aggressive feather pecking is an abnormal behaviour and is more persistent. It can result in abnormal feather loss. Feather loss is the most serious, as it leaves the skin exposed to physical injury and heat loss. Physical injury results in blood loss and can lead to cannibalism. Poorly feathered birds will need to consume more feed in order to generate heat. The most common feather pecking targets are on the back, rump and tail areas. Pheasants and game birds raised in captivity are notorious feather pickers (Dennis *et al*., 2009).

Head Pecking

Head pecking is often seen in overcrowded, young flocks, where the combs and wattles are the main targets.

Vent Pecking

Vent pecking is the most severe form of cannibalism. It is generally seen in high-production layer flocks or young overweight maturing hens. Layers with a history of some other pecking problem can also start vent pecking. The target area includes the vent or the region of the abdomen several inches below the vent. Two important predisposing factors are prolapsed oviduct and tearing of the tissues by the passage of an abnormally large egg. Vent pecking can result in anaemia due to blood loss. A prolapsed oviduct is usually permanent and results in other birds pecking until the affected bird bleeds to death. Affected birds need to be culled from the flock (Austic *et al.,* 1979).

CAUSES OF PECKING AND CANNIBALISM

Signs of pecking include uneasiness in the flock and shyness in some birds. There is a positive correlation between the amount of feather pecking damage sustained and the fearfulness of the flock. There are several causes of pecking and cannibalism that it is hard to pin point the exact cause. Nutrition and poor management are the most common triggers.

Nutritional Factors

The absence of feed or water, or a shortage of water and feeder space can cause pecking and cannibalism. Improper amount of feeder and waterer space per bird may develop cannibalistic behaviour in birds. Birds that have limited access to food will fight for access to it or if they are always hungry will increase their incidence of pecking. Hence, they require access to food and water at all times. Breeder flocks are often restricted access to feed to control their weight for optimal production and hence have higher incidences of pecking. Nutritionally unbalanced diets can also cause pecking in poultry. It is likely that a deficiency of any one of several nutrients may cause the bird to have a depraved appetite and may lead to cannibalism (Austic *et al.,* 1979).

Feather pecking has been linked to protein, methionine, sodium and phosphorus deficiencies. High sodium diets can also cause pecking. Mineral supplements such as sodium chloride, calcium chloride and manganese seem also to play uncertain roles. Extremely high energy and low fibre diets cause extra activity and aggressiveness in poultry. The reported prevalence of cannibalism on high corn-containing feeds indicates that corn is deficient in a factor necessary for the prevention of cannibalism or contains a factor which promotes it (Cloutier *et al.,* 2002).

Fibre plays very important role in development of cannibalism in poultry. Higher fibre diets will keep the crop full for a longer period of time, making the birds less prone to pecking. Several studies have shown that form of feed can also affect pecking and cannibalism. Crumbs are often preferred over pellet as it takes longer to consume, which means the bird spends more time in foraging and has less time for cannibalism and pecking. An additional study found that layers fed a mash diet exhibited significantly lower cannibalism, fewer skin lesions, and better feather condition than hens fed the same diet in a pelleted form. Feeding a balanced diet rich in various nutrients for various age and stage of production can prevent cannibalism in poultry. Research at the Poultry Division of the University of California indicated that corn aggravated and oats prevented cannibalism condition in poultry (Austic *et al.,* 1979).

Management Factors

Social stresses, such as stocking density, insufficient nests and boredom can cause pecking and cannibalism. Follow breed recommendations and provincial guidelines for stocking density to prevent overcrowding. Housing different poultry breeds, ages, colours and sizes that have not been reared together can upset the social order of birds. Avoid brooding feathered leg fowl, crested fowl or bearded fowl with fowl that lack these traits as curiosity can lead to cannibalism (Austic *et al.,* 1979).

Chicks should be allowed:

1/4 sq. ft. /bird for first 2 weeks
1/2 sq. ft. /bird for 3-8 weeks
1 sq. ft. /bird from 8 to 16 weeks of age
1.5 sq. ft. /bird from 16 weeks on

In game birds, double the above recommendations. With pheasants, allow 25 to 30 sq.ft./bird after 12 weeks of age or use pick prevention devices. If the birds have to fight for food and water, or if the birds are always hungry they will increase pecking. Be sure that birds have free access to water and feed at all times (Cloutier *et al.,* 2002).

Mixing of different types and colours of fowl:

Mixing different ages of fowl or fowl with different traits promotes pecking by disrupting the flocks normal pecking order. Never brood different species of birds together. Don't brood feathered leg fowl, crested fowl or bearded fowl with fowl without these traits. Curiosity can also start pecking (Cloutier *et al.,* 2002).

Abrupt changes in environment or management practices:

If you plan to move young birds to a new location, it is best to move some of their feeders and waterers with them in order to help them adapt. When you change over to larger feeders and waterers it is helpful to leave the smaller equipment in the pen for a few days to help during the change (Cloutier *et al.,* 2002).

Light Intensity

Extremely bright or excessively long periods of light can stress birds, causing them to become hostile to one another, leading to cannibalism. The standard light intensity used in poultry housing is 5-10 lux (0.5 to 1.0 foot candles). Provide an adequate amount of light for the first few days for broiler flocks in order to stimulate chick activity and ensure immediate water and feed consumption. This will prevent early dehydration and starve-out losses. Older birds should have a lower light intensity to maintain calmness in the flock. Be cautious in adjusting the lighting program for layer and breeder flocks as they require light stimulation for egg production. Red covers over lights can be used to calm otherwise aggressive, flighty birds. Follow breed recommendations and maintain adequate light for growth and production (Fraser and Broom, 1990).

Slow feathering birds are most prone to cannibalism:

Take extra precautions with slow feathering birds. Most cannibalism occurs during feather growth in young fowl. Birds with slow feathering have immature tender feathers exposed for longer periods of time leaving them open to damage from pecking. Don't raise slow feathering birds with other fowl (Cloutier*et al.,* 2002).

TREATMENT OF CANNIBALISM

Due to the numerous causes of pecking and cannibalism, it is often very hard to determine the exact cause. However, some sort of stress is usually the cause. If a pecking problem is noticed in its early stages, it can be held in check. If pecking is left to get out of control and leads to cannibalism, it can be very costly to the producer. Cannibalism can lower the value of the birds due to damaged flesh, poor feathering and can result in high mortality. Once it gets out of hand it is very hard to eliminate. If you notice any pecking behaviour, try to correct any management or nutritional issues before it leads to cannibalism. Applying an "anti-peck" ointment or pine tar on any damaged birds usually stops pecking. Darken facilities by using red covers on light bulbs or red bulbs to calm the birds, and reduce the temperature slightly, if possible. Remove any badly injured birds and those that show aggressive pecking. Small flock producers can try using anti-peck ointment or pine tar on injured birds to defer pecking or provide alternative pecking objects such as straw bales, etc(Austic *et al.,* 1979).

Beak Trimming

Beak trimming is a routine husbandry procedure in the commercial poultry industry, particularly in breeding and laying hens. Its purpose is to reduce or inhibit feather pecking and aggressive pecking. The conventional hot-blade beak trimming is the preferred method, which involves the removal of part of the upper and lower mandibles with a heated blade. This is performed on chicks between one and ten days of age, with further trimming, if necessary, at 10-12 weeks of age. A recent study showed that infra-red beak trimming resulted in a less painful, more precise beak trimming method compared with the hot-blade method. While infra-red treated birds had longer beak stumps, they had excellent feather condition and reduced aggressiveness under high light intensity (Cloutier*et al.,* 2002)..

Excessive Light

Excessive heat can cause poultry to become aggressive and cannibalistic. Follow breeder recommended temperatures, making sure you decrease heat as birds get older. To ensure you have the correct temperature for the age of the flock, measure the temperature at the height of the birds back directly under the heat source. In older birds, use 15 or 25 watt bulbs above feeding and watering areas. Extremely bright light or excessively long periods of light will cause birds to become hostile toward one another. Never use white light bulbs larger than 40 watts to brood fowl. Do not heat the entire brooding facility – always provide cooler areas for the birds to escape the heat if they become overheated. Use equipment designed for providing heat in brooding facilities, such as infra-red heat lamps, tube radient heaters or pancake brooders (Dennis *et al*., 2009)..

Excessive heat:

When the birds become uncomfortably hot they can become extremely cannibalistic. Be sure to adjust the brooding temperature as the young fowl get older. Brood young fowl at 95°F for the first week and then decrease the temperature 5°F per week, until reach 70°F or the outside temperature. The temperature should be measured at the height of the birds back directly under the heat source. Do not heat the entire brooding facility to the recommended temperature (Fraser and Broom,1990)

PREVENTION

Prevention is the key to avoiding pecking and cannibalism in poultry. Below are a few key preventative measures:

1. Feed a well-balanced diet that is appropriate for the age and stage of production of your flock. Provide appropriate feeding and drinking systems that provide lots of space for the size of your flock (Cloutier *et al.,* 2002).

2. Practice good management skills by provide adequate floor and nest space, good ventilation, proper temperature and light intensity.
3. Treat any parasitic problems immediately.
4. Have a professional trim the beaks of commercial layer flocks.
5. Provide enriched environments for small backyard flocks. Enrichment ideas include access to the outside, nest boxes and perches, providing scratch grain and fresh greens in the litter to promote natural foraging behaviour.
6. Walking through poultry flock at least twice daily to look for and remove any crippled, injured or dead birds.
7. Prevention of overcrowding.
8. Provision of adequate feeding and watering facilities
9. Devices to keep birds busy
10. Use coloured lights so that birds will not see bloody parts of picked birds
11. Debeaking is the surest means of controlling cannibalism. The procedure is to remove a portion-about one half-of the upper beak by means of a heated knife or iron which cauterizes the tissue and prevents bleeding.

CONCLUSIONS

Cannibalism is a serious threat to the poultry industry, which causes great economic loss to the poultry farmers and entrepreneurs. This can be prevented by adopting proper nutrition, care and management of poultry farm.

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The Impact of Information and Communication Technology (ICT) on Animal Husbandry

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Playing a significant role in national economy as well as socio-economic development of millions of rural households, Animal Husbandry forms an indispensable part of the agriculture system in India. Globalization and growing competition have expedited the demand for knowledge in-depth work performance in various economic sectors. Farmer's needs are much more variegated and the knowledge required to deal them is ahead of the capability of the grass root level extension functionaries (Sharma, 2003). ICT is a generic term encompassing all communication technologies such as internet, wireless networks, cell phones, satellite communications, digital television etc. that are used for collecting, storing, editing and passing on (communicating) information in various forms. ICT as a sector can effectively contribute to the national GDP of a nation which can result in improved market competitiveness of a nation's products and services as well as boost biodiversity utilization and management. It has great prospects to bring upon the necessary social transformation by inflating access to services, information and other technologies to people (Dutton et al., 2004). The systematic application of ICTs within framework of livestock services helps in circulating knowledge to the farming communities for better and up-to-date decision making at the farm level (Gulati et al., 2007). Valuable information on livestock diseases, nutrition, treatment and control of diseases, breeding techniques and markets for their products is made available to the livestock rearers by the use of ICT in order to increase productivity and hence improve their livelihoods.

The state Agricultural and Animal Husbandry agencies face limited budgetary allocations (Sasidhar and Chandel, 2003), insufficient infrastructure and human resources (Bhat and Das, 2002). This results in their reliance on information about the new technologies provided by training or research institutions which consequently demands more investment of time, energy, cost and other resources.

Limitations of conventional Animal husbandry Extension Methods

1. Expensive: It requires a lot of finance to produce and print extension materials and to educate a whole network of livestock extension personnel.

2. Time Consuming: Dissemination of information from a research station/university to the livestock owners involve many intermediates to understand and deliver the message to next level.
3. Information Distortion: The quality of the information to be delivered get heavily altered when it ultimately reaches to the end users as suggested by various studies.
4. Inadequate Communication Capacity: There may be wide gap between the technologies propagated from the research facilities and adopted by the receivers.
5. Neglect of Technology Transfer in Livestock Production:

Various factors contributing to neglecting the Technology transfer may be stated as follows:

(a) A focus on crop production instead of livestock production is preferred mostly by extension services although the requirement for livestock products is more than that for crops.

(b) The aim of animal husbandry extension is more on production aspects rather than on animal health which speaks of the limited capacity of conventional livestock extension system. Thus restricting information transfer to the livestock owners (Mathewman and Mortan, 1995).

Hence a backup source to accouter to the grass root level extension workers with proper information is needed and in this regard Information and Communication Technology (ICT) tools play important role (Sasidhar and Sharma, 2006). ICT will help to reduce the constraints of poor accessibility to apt information for a range of stakeholders like government departments staffs, NGOs, producer groups, farmers and various other extension delivery agents.

The use of ICT tools broadens the knowledge level of the users and also furthers better quality decisions (Raut et al., 2011) resulting in more efficient, effective and competitive organizations (Fink and Disterer, 2006). These tools have the advantage of speed, accuracy, timeliness, reliability, cost effective, bridging distances expediting self training and also preparing trainees for future circumstances. New ICTs include community radio and television, cellular telephony, use of computing devices, digital imaging, the internet and wide area Networking (WAN), Wi-Fi and Mixed Media are inexpensive, smarter, compact, cost effective and easily available, have revolutionized the methods of receiving, storing, disseminating information and communication for agricultural development (Grover and Saeed 2007). For Example use of radio for internet access and Internet radio, SMS services and WAP (Wireless Access Protocol) based Internet access using cellular telephony as also embedded use of micro-processors, computing devices and applications and digital media in processes and systems for data and information management and communications.

Cyber extension can be uploaded at any time as and when required by the users according to their needs. Any valuable information can be directly posted on the Internet, which will be available to extension functionaries and farmers thereby removing a number of steps altogether from the traditional extension process.

Major project conducted in rural area like Bhoomi Project, Gyandoot Project, Warana Wired Village Project, IKISAN Project, FRIENDS, e-VET etc. aimed at using Information Communication Technology (ICT) to boost veterinary services to livestock rearers providing opportunity of health care services for livestock within affordable cost and at minimum time. It also enhanced documenting and disease surveillance, timely counsel on the livestock prices as well as livestock products resulting in increased incomes and better livelihood opportunities.

ICT, in National Dairy Development Board, is exercised at milk collection centre and in Cooperatives to measure butter fat content of milk, test the quality of milk and make payments to the farmers/livestock owners instantly. It consequently results in the elimination of incentives to those who adulterated milk, reduced the time for payment and build-up the confidence in farmers on cooperative systems.

The National Agricultural Research System (NARS) under the Indian Council of Agricultural Research supports numerous State Agricultural Universities (SAUs), Project Directorates, All India Coordinated Research Projects (AICRPs) in various fields and Krishi Vigyan Kendras, almost one per district in the country. The ICAR has taken considerable measures for the ongoing revolution in IT to meet the needs of scientists, extension workers, research managers, farmers and students (Rai 2003).

CONCLUSION

ICT industry act as a significant contributor to GDP.The accomplishment of ICT applications in animal husbandry depends upon many factors like farmers' acceptance of ICTs, political and policy environment, farmers' educational standing, ICT connectivity and infrastructure, rural information models etc. The void between the ICT tools developed by various institutes and the livestock keepers' needs and content both in terms of quality and quantity are acting as obstacles for mass upgradation. The potential of ICT can only be harnessed when these limitations are overcome. It is noteworthy to mention here that ICTs are only complementary and cannot act as a substitute for the existing public extension system. Going beyond its food production function, livestock provides draft power and organic manure for agriculture and fuel for household purpose. Development in animal husbandry is thus reckoned to condense interpersonal and inter regional divide and lessen poverty. Thus, ICT proves to be effective for coverage and dissemination of livestock outreach information to the farming community.

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Mushrooms: Income and nutrition for the rural livelihood

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Mushroom cultivation is playing a vital role in helping rural community make stronger their livelihoods. It is well-organized income for change of agricultural wastes like hey, paddy straw etc. into precious protein and making added profits as well as reduce unemployment. Mushrooms are able to successfully grown without utilization of land, and can provide a regular income throughout the year. Cultivation is also independent of weather, and can recycle agricultural by-products as composted substrate which, in turn, can be used as organic mulch in growing other horticultural crops, including vegetables (Marshall and Nair, 2009). In India, mushroom cultivation till now not covered as per their potential. Recently, unemployment is increasing. In this situation, self employment can be one important way to increase employment rate for farm households for creating employment and earning extra income.

Presently in Odisha three varieties of mushroom cultivated in rural areas *viz.* white mushroom (*Agaricus bisporus*), paddy straw mushroom (*Volvariella vovacea*) and oyster mushroom (*Plutorus sajar-caju*). These mushrooms (*Pleurotus*) are a good quality source of non- starchy carbohydrates and medium quantity of proteins, minerals, and vitamins (Croan ,2004), The content of protein differ from 1.6 to 2.5%. According to the Randive (2012), oyster mushrooms are rich in Vitamin C, B complex, and mineral salts, which necessary to the human being .

Table 1: Mushroom species and their corresponding cultivation medium

Growing Medium	Mushroom Species
Rice straw	Straw (*Volvariella)*, Oyster (*Pleurotus*), Common (*Agaricus*)
Sawdust	Shiitake (*Lentinus*), Oyster (*Pleurotus*), Lion's Head or Pom Pom (*Hericium*), Ear (*Auricularis*), Ganoderma (*Reishi*), Maitake (*Grifola frondosa*), Winter (*Flammulina*)
Cotton waste from textile	Oyster (*Pleurotus*), Straw (*Volvariella*)

industry	
Cotton seed hulls	Oyster (*Pleurotus*), Shiitake (*Lentinus*)
Sawdust-rice bran	Nameko (*Pholiota*), Ear (*Auricularis*), Shaggy Mane (*Coprinus*), Winter (*Flammulina*), Shiitake (*Lentinus*)
Corncobs	Oyster (*Pleurotus*), Pom Pom (*Hericium*), Shiitake (*Lentinus*)
Oil palm waste	Straw (*Volvariella*)
Bean straw	Oyster (*Pleurotus*)
Cotton straw	Oyster (*Pleurotus*)
Banana leaves	Straw (*Volvariella*)
Source: Beetz, A.and Kustudia, 2004.	

Success story

A success story of Krishi Vigyan Kendra, Malkangiri. Sri Dashrathi Behera, a middle aged farmer from Talasai village of Malkangiri block is an actually model in their region. He has only 2.0 acr land and cultivates rice in kharif season and in Rabi season land kept fallow due to the irrigation problem. Money earned through rice cultivation is not sufficient for their livelihood.

During the field visit of his area, the scientist of KVK came to know their problem and suggested them for mushroom cultivation for extra income and keeping the farmers problems, a mushroom training was organized at KVK campus and the KVK scientists established the homework of mushroom bed (oyster) which includes size of the paddy straw, method of preparing bed, spreading of spawn in each layer of the bed, moisture and temperature and duration of fruiting as well as harvesting technique. Being trained on mushroom cultivation, he firstly hesitates for success of this cultivation and prepared only two beds by the support of KVK (FLD). After successful experiment, he thought that it may be the source of profits as he can dedicate a few hours in this movement because he earned much money with less investment in only two beds. He started putting more numbers of beds for more income.

The cost of cultivation for one Oyster mushroom bed is around Rs.50/- including cost of spawn, pulses grind, polythin etc. and the net return is Rs.150/- per bed. The B: C ratio is Rs. 4.0:1. By getting the profit from mushroom, he came to KVK office and communicated with scientists regarding the marketing and preparation of low cost mushroom unit for large scale production. As per the advice given by scientists, he prepared one shed room for said purpose as well as communicated with hotel and restaurant people for better marketing. This time his annually income is enhanced and exceeding more than one lac. By seeing his success, more than 50 farmers started this business as well as this technology spread over 150 numbers of farmers in Malkangiri, Korukonda and Kalimela blocks of Malkangiri district.

Possessions formed through profit:

The profit earned from mushroom, he purchased a mobile phone to make their better marketing of their produce by good communication.

Future ambition:

He is now interested to make a vermicompost unit for better utilization of waste materials of bed as well as interested to produce organic vegetables by using vermicompost.

CONCLUSION

Mushrooms are fast growing, supply the healthy food as well as can provide a source of income. Farming does not need more money investment or access to land, as mushrooms can be grown-up on substrate prepared from any clean agricultural waste materials.

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Cluster Bean: A Novel Alternative for Commercial Guar Gum Production

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Abstract

Guar gum is a novel agrochemical processed from endosperm of cluster bean. It is largely used in the form of guar gum powder as an additive in food, pharmaceuticals, paper, textile, explosive, oil well drilling and cosmetics industry. Industrial applications of guar gum are possible because of its ability to form hydrogen bonding with water molecule. Thus, it is chiefly used as thickener and stabilizer. It is also beneficial in the control of many health problems like diabetes, bowel movements, heart disease and colon cancer.

Key Words: Cluster bean, Novel alternative, Production, Commercial

INTRODUCTION

Guar gum is obtained from the seeds of the drought tolerant plant *Cyamopsis tetragonoloba*, a member of Leguminosae family (Whistler and Hymowitz, 1979; Kay 1979; Prem et al., 2005). The common names used in the scientific literature for the bean, guar gum flour and the galactomannan fraction are Indian cluster bean, guar and guaran, respectively. There is lack of general consensus with regard to the origins of this plant (Whistler and Hymowitz, 1979), although the concept of trans-domestication was originally proposed by Hymowitz (1972). The domesticated species is normally associated with India and Pakistan, where the plant has been grown for centuries as food for both human and animals (Whistler and Hymowitz, 1979). Guar gum industry developed in the 1940s and 1950s in United States (BeMiller, 2009). Guar was introduced from the United States before World War I primarily as a green manure but was not used in industrial applications until 1943 and probably it was the main reason why it has been studied to a limited scale.

The commercial development of cluster bean was made at the University of Arizona during World War II. At the close of the war the gum was examined by Whistler (1948) at Purdue. He worked on the molecular structure and, in examining the properties of the pure polysaccharide, guaran, visualized its wide industrial potential and recommended development of the guar plant as a domestic crop for industry (Whistler, 1948; Whistler and Hymowitz, 1979). Guar gum resembles locust bean gum in being composed essentially of the complex carbohydrate polymer of galactose and mannose, but with different proportions of these two sugars. It is reported that guar flour is of value as a beater additive for improving the strength of certain grades of paper. It has also been reported that guar possesses properties which might be useful in warp sizing, printing pastes, and in certain finishing operations. In order to obtain the gum it is necessary to separate the gum-containing endosperm of the seed from the outer and largely fibrous portions. Guar seed endosperm is a source of water soluble gum which is used as stabilizer, emulsifier and thickener in various food products and contributes to soluble dietary fiber (SDF) portion of seed total dietary fiber (TDF). TDF and SDF, respectively, made up 52–58% and 26–32% of seed dry weight (Kays et al., 2006). As a food additive, it emulsifies, binds water, prevents ice crystals in frozen products, moisturizes, thickens, stabilizes and suspends many liquid–solid systems. It is used in ice cream, sauces, cake mixes, cheese spreads, fruit drinks and dressings usually in amount of <1% of the food weight (Whistler and Hymowitz, 1979; Parija et al., 2001).

PRODUCTION

Guar gum is a gel-forming galactomannan extracted from grinding the endosperm portion of *Cyamopsis tetragonoloba*, a leguminous plant grown for centuries mainly in India and Pakistan where it is a most important crop that has long been used as food for humans and animals (Chandirami, 1957). The guar plant is essentially a sun-loving plant, tolerant of high environmental temperatures but very susceptible to frost (Whistler and Hymowitz, 1979; Kay, 1979). For maximum growth the plant requires a soil temperature of 25–30 °C and ideally, a dry climate with sparse but regular rainfall. Guar plant requires rain for optimum growth before planting and again to induce maturation of seeds (Anderson, 1949). Excess of moisture during early phase of growth and after maturation of seeds results in lower quality guar beans (Heyne & Whistler, 1948; Venkateswarlu et al., 1982). Guar is also cultivated in the southern hemisphere in semi-arid zones in Brazil, Australia, South Africa and Southern part of the USA like Texas or Arizona. The total production of guar seed in these countries is estimated at 15,000 MT annually. The agro-climatic conditions in Australia are also quite conducive to the cultivation of guar. Efforts have been made to promote cultivation of guar in Australia by the Department of Agriculture and Rural Industrial Development Agency. Similarly, it is reported that countries like China and Thailand are also trying to grow guar. Therefore, in future guar may not remain monopoly of India and Pakistan.

India contributes for 80% of the total guar produced in the world and 70% of it is cultivated in Rajasthan. India is the world leader for production of guar, which is grown in the northwestern parts of country encompassing states of Rajasthan, Gujrat, Haryana and Punjab. During 1970s guar was also grown regularly in the State of Uttar Pradesh (U.P.), Madhya Pradesh (M.P.) and Orissa. As the processing facilities have been closed down in U.P. and M.P., the cultivation in these states is negligible now. In Orissa too guar is not cultivated any more. The annual production of guar during last 3 years ranged from 11, 00,000 to 12, 87,000 MT.

PROCESSING:

Guar gum processing differs from plant to plant. The general outline of the manufacturing process of guar gum is shown in Fig. 1. When guar seeds are removed from their pods these are spherical in shape, brownish in color, smaller than pea seeds in size.

The gum is commercially obtained from seeds essentially by a mechanical process of roasting, differential attrition, sieving and polishing. The seeds are broken and the germ is separated from the endosperm. Two halves of the endosperm are obtained from each seed and are known as undehusked guar split. When the fine layer of fibrous material, which forms the husk, is removed and separated from the endosperm halves by polishing, refined guar splits are obtained.

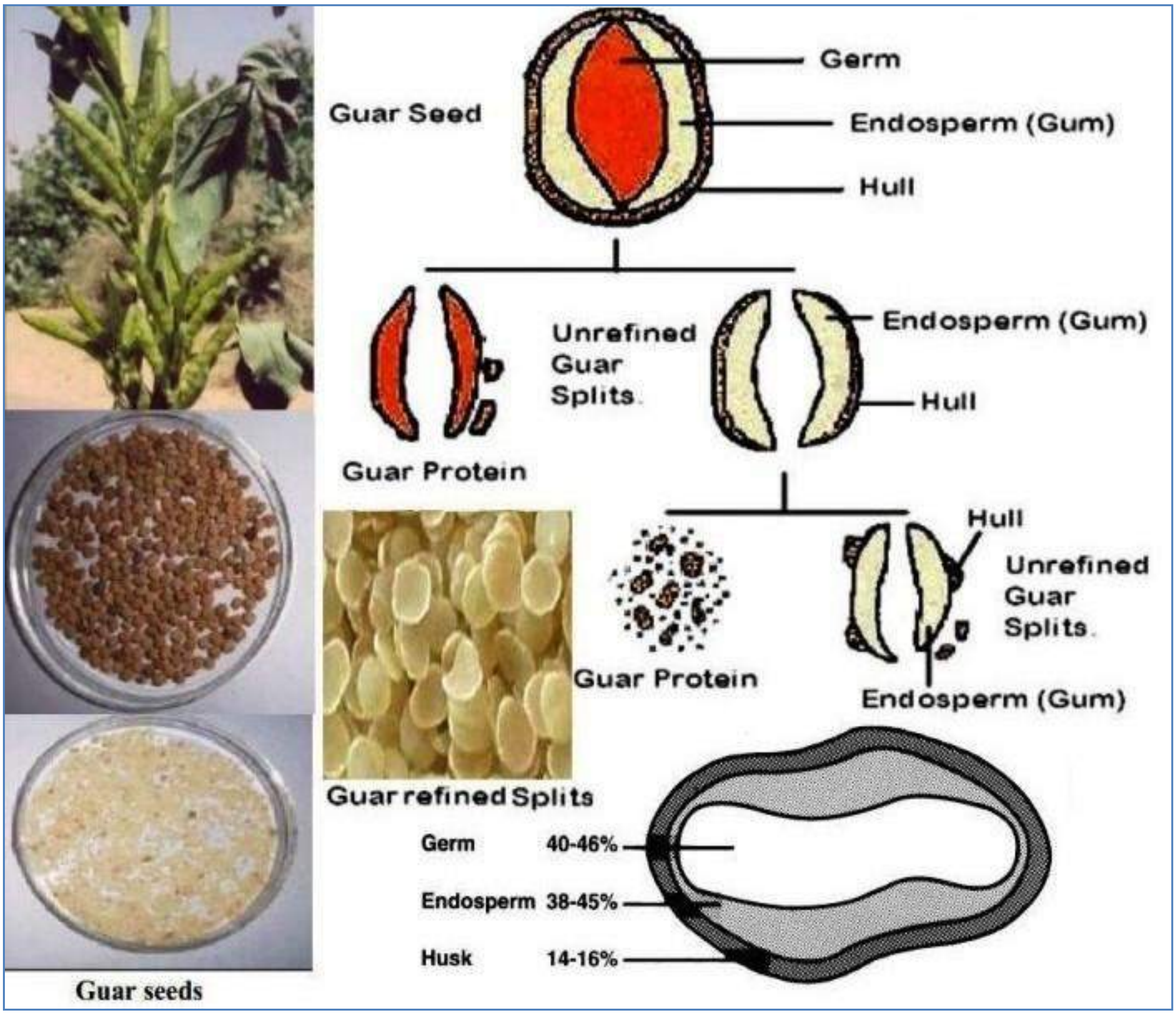

Figure 1. Guar gum processing representation

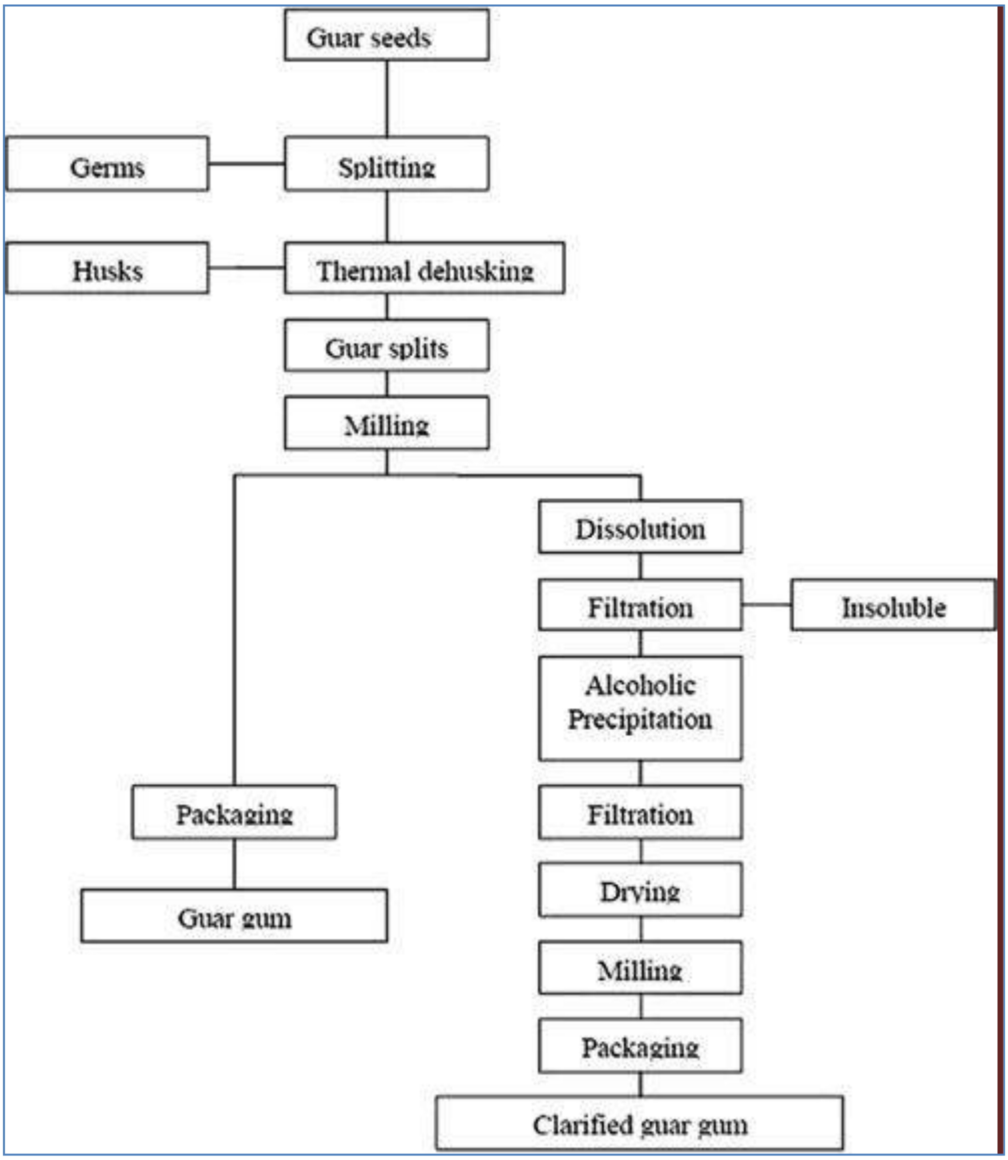

Figure 2. Flow diagram for industrial manufacturing of guar gum

The hull (husk) and germ portion of guar seed are termed as guar meal which is a major byproduct of guar gum powder processing and is utilized as cattle feed. The refined guar splits are then treated and finished into powders (known as guar gum) by a variety of routes and processing techniques depending upon the end product desired. The pre hydrated guar splits are crushed in flacker mill and then uniformly moved to ultra fine grinder, which grinds the splits without producing too much heat. The grinded material is dried and passed through screens for grading of the material according to the particle size. Various grades are available depending upon color, mesh size, viscosity potential and rate of hydration (Chudzikowski 1971). In industrial processing of guar gum extrusion is also included before hydration and flaking. After these steps grinding and drying are done. Inclusion of extrusion gives guar gum powder with improved hydration rate (Chowdhary, 2002). The byproducts of guar gum industry are Churi and Korma which are utilized for cattle feed.

CONCLUSION

Guar gum is a chief agrochemical extracted from the seed endosperm of guar plant i.e. *Cymopsis tetragonoloba* which is cultivated in India and Pakistan from ancient times. Guar gum is a useful material to investigate. It has a strong hydrogen bond forming tendency in water which makes it a novel thickener and stabilizer. Aqueous solutions of guar gum are very viscous in nature. Because of these properties it has wide applications in the industries like food, pharmaceutical, textile, oil, paint, paper, explosive and cosmetics. Another reason for its popularity in the industry is its low cost. Its economical nature makes it popular in gums and stabilizers industry. In food industry, it has wide applications in ice cream, sauce, beverages, bakery and meat industry. It is also used in food products for supplementation as dietary fiber. Its consumption reduces the risk of heart diseases by reducing the cholesterol level in body, control diabetes and maintains the bowel movement in human beings.

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Stem canker (*Phoma cajani*) of Pigeonpea- a sporadic disease but epidemic in congenial environment

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Pigeonpea is an important grain legume crop of rain fed agriculture in the semi-arid tropics. The Indian subcontinent, Eastern Africa and Central America are the World's three main pigeonpea producing regions. It is cultivated in more than 25 tropical and sub-tropical countries, either as a sole crop or intermixed with such cereals as sorghum, pearl millet, maize, or with legume, e.g. peanut (Shah and Agarwal, 2009). In India, Pigeonpea is second most important grain legume after chickpea. More than 50 diseases have been reported to affect pigeonpea but fortunately only few of them are of economic importance. These include Phoma canker (*Phoma cajani* Rangel), Macrophomina stem canker (*Macrophomina phaseolina* Tassi), Wilt (*Fusarium udum* Butler), sterility mosaic, Phytophthora blight, Withes broom (virus & mycoplasma), Rust (*Uredo cajani*) and leaf spot (*Cercospora cajani* Henn.). Phoma stem canker of pigeonpea caused by *Phoma cajani* is a sporadic disease but occasionally attains highly destructive proposition and becomes epidemic where environmental condition is congenial. It becomes more serious in the dry weather at high temperature during February and March when the crop is at maturity stage. When reported as early as 1965 it was considered to be a minor disease but progressively severe in recent years causing more economic losses to pigeonpea production. The disease was repeatedly seen in experimental plots and farmers fields causing 5-50 % mortality in plants at maturity stage during the periodical surveys and critical observations.

Symptomatology

Symptoms of the disease were observed in second week of July to pre flowering and maturity stages of the plant growth. The severe incidence of disease was also seen in the month of February to March.The pathogen *Phoma cajani* produces distinct symptoms mainly on the stem but sometimes on branches also when plant was 2-3 months old. Small, sunken ashen grey colored lesions appeared on stem about 0.5- 3 cm. above the ground level. In favourable conditions lesions enlarged and attained 2.5-13 cm × 0.5-1.6 cm size, finally becoming swollen and cankerous. Numerous pinheads like dark pycnidia appeared on the sunken area which remained partly buried in the cortex. In advanced stage of the disease several lesions coalesce to form large irregular stripes on the stems. Lesions generally enlarge longitudinally and the affected site swells breaking open the bark and more cankerous with the age (Plate-1). The disease become more severe with maturity stage of crop often confused with wilt. At the mid-pod fill stage plant show symptoms like wilting and finally died. Symptoms recorded during the present study is similar to those described by Khune and Kapoor (1981).

The dead stem and branches change to whitish grey with abundance of pycnidia developed on these (plate- 2). All the fungal isolates collected from stem canker affected pigeonpea plants and exhibited typical characteristic of *P. cajani* described by Khune and Kapoor (1981) i.e., dark brown and papillate pycnidia of variable size with conspicuous ostiole, pycnidiospores hyaline, round to ovate, one-celled arise from conidiogenous cells lining the pycnidial cavity. Spores are colorless and unicellular. Pycnidia are the large, round to puriform, asexual fruiting bodies and have one to several openings on their surface from which the pycnidiospores are released outside (Kirk *et al.,* 2008). Optimum temperature and relative humidity for the growth of pathogen varies 25^0 to 30^0 and70 % to 80% respectively.

***In-vitro* evaluation of fungicides on the radial growth:**

Response of the isolate of *Phoma cajani* to ten concentrations (i.e., 50, 100, 150, 200, 250, 300, 350, 400, 450 and 500 ppm) of different fungicides viz., SAAF, Benfil, Vitavax and Dithane M-45, was studied to determine differences in tolerance to various toxicants. Table 1. shows that different fungicides have profound inhibitory effect on isolate of *P. cajani* at its different concentrations. There was significant difference among the mycelial growth averages of *P. cajani* obtained with different dosages of fungicides. Pronounced reduction of growth occurred in medium with increasing concentrations of fungicides. Maximum percent inhibition of radial growth of the fungus was observed at a concentration of 300 ppm (83.33%) of SAAF, 350 ppm (80%) of Benfil, where as Vitavax and Dithane M 45 were required at equal concentrations (400 ppm) for maximum percent inhibition of radial growth (86.38%, 81.94% respectively) of the fungus.

The growth of the stem containing pathogen was inhibited completely at one or another concentration. SAAF most effectively controlled *P. cajani* at 350 ppm. In contrast, Benfil, Vitavax and Dithane M 45 required higher concentrations (400 ppm, 450 ppm and 450 ppm respectively) than SAAF for complete inhibition of mycelial growth . The use of chemical fungicides cannot be avoided since there is no other method of disease management (Sateesh, 1998). When thought of in terms of cost effectiveness, fungicides provide a cheaper and reliable source for the control of plant pathogenic fungi. In spite of well known hazards associated with the use of chemicals, Norman Borlaug, father of the green revolution, argued strongly for the use of synthetic chemical in plant disease control (Nigam *et al.,* 1994). In general, before subjecting any fungicide for field trials, they should be screened in the laboratory against the plant pathogen. The poison-food technique and spore germination test in shaker culture are one of the few common methods employed to test the efficacy of fungicides under laboratory conditions (Dhingra & Sinclair 1995).

In present studies SAAF, Benfil, Vitavax and Dithane M-45 completely suppressed radial growth of *P. cajani* at a particular concentration. Significant decrease in mycelial growth with higher concentration of fungicide was recorded. Among the 4 chemical fungicides used, SAAF (Carbendazim 12% + Mancozeb 63%) was found to be most effective at a comparatively lower concentration (300 ppm) followed by Benfil (Carbendazim 50%) whereas Vitavax and Dithane M 45 required equal concentrations (400 ppm) for maximum percent inhibition of radial growth of the fungus. After computing it was concluded that the commercial fungicide i.e., SAAF (Carbendazim 12% + Mancozeb 63%), which was a mixture of both systemic and contact fungicides was best among all the chemicals used.

Plate 1: Symptoms of Phoma stem canker of pigeonpea A. Water soaked lesion on the stem B. Lesion girdled stem C. Severe canker stage D. Cracked stem at cankerous site

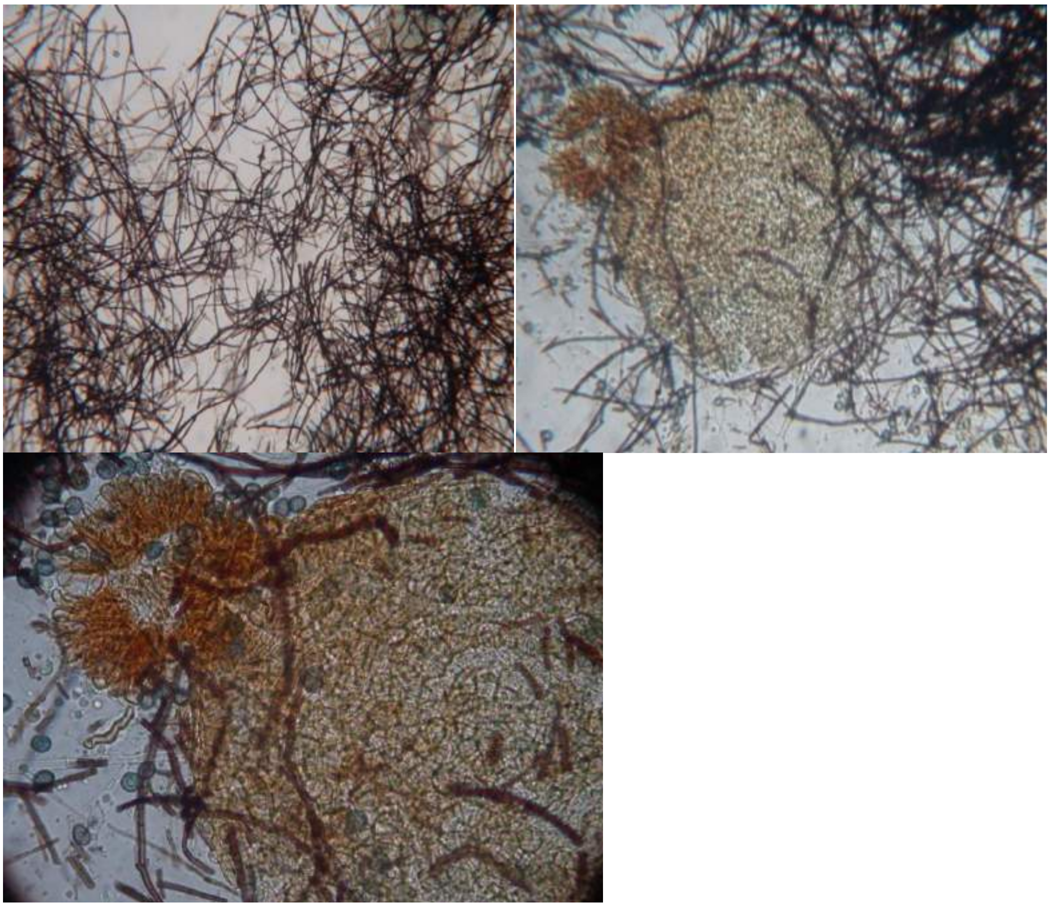

Plate 2: Cultural characteristics of pathogen A. Mycelium B. Initiation of pycnidia formation C. Release of pycnidiospores

Table 1. Effect of different fungicides on radial growth of *P. cajani*

Fungicides	% inhibition of radial growth* Concentration (ppm)										
	50	**100**	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**Mean**
SAAF	40.27	48.61	55.55	71.38	78.04	83.33	100	100	100	100	77.72
Benfil	30.83	40.83	49.44	60.83	69.16	74.44	80	100	100	100	70.55
Vitavax	16.93	29.16	39.16	54.44	63.88	73.88	78.88	86.38	100	100	64.27
Dithane M 45	14.44	25.27	31.38	39.99	50.27	62.22	71.94	81.94	100	100	57.74
SEm±	1.92	1.85	1.73	1.34	2.54	1.26	0.92	1	0	0	
CD (P=0.05)	4.2	4.04	3.78	2.93	5.53	2.74	2.02	2.18	0	0	
CD (P=0.01)	5.89	5.67	5.3	4.12	7.76	3.85	2.83	3.06	0	0	

**On 5th day after inoculation.*

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Livestock Improvement in Small and Marginal Farmers House Hold in West Bengal

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West Bengal lies in lower gangetic plain region of India. The average annual rainfall lies between 100-200 cm and temperature varies from 26°C- 41°C in summer and 9°C - 24°C in winter. The region has adequate storage of ground water, rice is the main cereal crop followed by jute, maize, potato, and pulses are other important crops. Livestock generating employment, income and has become an important component of rural development programmes i.e., "Equity and extending benefits directly to women" making a significant contribution to the national economy and socio-economic development. West Bengal contributing 3.89 % of the State domestic product (SDP) and nearly 20.34% of its agriculture production. The buffalos of this region are few, non-descript, less productive and poorly developed. Women play a major role in livestock production and most small marginal and landless rural farmers traditionally rear goat, sheep, poultry, cattle and buffalo, as they generally follow the extensive management system, primarily poor natural vegetation and crop stubbles, without any supplementation. By virtue of high fecundity and better productivity, goat assured income to the rural population with low input cost in diverse agro-climatic condition. Augmentation of production and productivity is the most challenging constraint and availability of feed and fodder is another serious constraint. All livestock and poultry are indigenous and low-productive these stand in the way of the effective growth of this sector. Animal resources development department, Govt. of West Bengal is basically responsible for formulation and implementation of Livestock and Poultry policies and programmes and has been providing assistance to the State Government for the control of animal diseases, scientific management and up-gradation of genetic resources, sustainable development of processing and marketing facilities and enhancement of production and profitability of livestock enterprises. The prime lookout of is to increase production of milk and milk products of good quality. The recommendation of the Indian Council of Medical Research (ICMR) in respect of milk requirement, is at least 220 gm per capita per day (WHO recommends 210 gm and the State's norms 180 gm). The present per capita milk availability is 144 gm per day. The basic mandate is to improve milk production through development of genetically superior milk producing bovine population of this State.

LIVESTOCK SCENARIO OF WEST BENGAL

Table No.1: Livestock Population of India and West Bengal

S. No.	Species	India (Millions)	India Ranks	West Bengal (Lakhs)	West Bengal Ranks
1	Cattle	190.90	2rd	165.14	3rd
2	Buffaloes	108.70	1st	5.97	18th
3	Sheep	65.07	3rd	10.76	10th
4	Goats	135.17	2nd	115.05	4th
5	Horse & Ponies	0.63		0.01	
6	Yaks				5th
7	Camels	0.40		0.0026	
8	Pigs	10.29	10th	6.48	5th
	Total Livestock	512.06		303.48	
	Total Poultry	729.21	3rd in egg 4th in meat	528.37(Chicken) 60.83(Duck)	5th in Chicken 1st in Chicken

Source- 19th Livestock census, 2012

Table No.2: Contribution of the state West Bengal in the country

Parameters	India (2015-16)	India (2014-2015)
Milk production (million tonnes)	155.41	5.09(3.18%)
Egg Production (Billion)	78.48	4.92
Poultry meat production (million tonnes)	3.05	0.657
Meat production (million tonnes)	6.70	0.676
Wool production (million kgs)	48.10	-
Per capita milk availability (g/ day)	337	145
Per capita availability of egg (number/Year)	63	55

Source- 19th Livestock census, 2012

Table No 3: Average Yield Per Animal in Milk

Species	India (2014-2015)
Exotic/Crossbred Cows (Kg/day)	7.15
Indigenous/Non-descript Cows (Kg/day)	2.54
Buffalo (Kg/day)	5.15
Goat (Kg/day)	0.46

Source- 19th Livestock census, 2012

Table No 4: Species-wise Milk Production (Percentage)

Species	India (2014-2015)
Exotic/Crossbred Cows	25%
Indigenous/Non-descript Cows	20%
Buffalo	51%
Goat	4%

Source- 19th Livestock census, 2012

Table No 5: Number of veterinary institutions in West Bengal

Parameters	India
Veterinary hospitals and polyclinics	14 and 8
Veterinary dispensary	26034
Veterinary aid centre (Stockman centres /Mobile dispensaries)	2652
Fodder farm	14
Bull mother farm	2
Animal feed plant	7
Number of cattle breeding farm under Animal Husbandry department	5
Number of poultry breeding farm under Animal Husbandry department	27
Number of sheep breeding farms under Animal Husbandry department	8
Number of goat breeding farms under Animal Husbandry department	6
State animal health centres	92
Block animal health centres	339
Additional block animal health centres	271

Source: Report on Animal Husbandry and Veterinary Department, Govt. of WB 2012

Women play a major role in livestock production and most small marginal and landless rural farmers traditionally rear goat, sheep, poultry, cattle and buffalo, as they generally follow the extensive management system, primarily poor natural vegetation and crop stubbles, without any supplementation. By virtue of high fecundity and better productivity, goat assured income to the rural population with low input cost in diverse agro-climatic condition. Augmentation of production and productivity is the most challenging constraint and availability of feed and fodder is another serious constraint. All livestock and poultry are indigenous and low-productive these stand in the way of the effective growth of this sector. Animal resources development department, Govt. of West Bengal is basically responsible for formulation and implementation of Livestock and Poultry policies and programmes and has been providing assistance to the State Government for the control of animal diseases, scientific management and up-gradation of genetic resources, sustainable development of processing and marketing facilities and enhancement of production and profitability of livestock enterprises.

Happy seeder technology for managing crop residues

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Abstract

A large quantity of residue is produced from crop harvests. These residues are mostly used as feed for cattle. In order to vacate fields for timely sowing of succeeding crop, majority of these residues are burnt in situ by the farmers as they interfere with normal agricultural operations. Burning of crop stubble and residues is rapid and cheap option for farmer which causes a serious atmospheric pollution as well as human health. Besides, it also results in the loss of plant nutrients and organic carbon of the soil and thus deteriorates the soil health. A novel approach to combat this problem is the happy seeder. It is a tractor-mounted machine that cuts and lifts straw, sows seed into the bare soil, and deposits the straw over the sown area as mulch. This technology is having positive edge over the conventional practices in terms of economics, water saving, diesel saving and eco-friendly technology to manage crop residues.

Key words: Burning crop, eco friendly, happy seeder, residue.

INTRODUCTION

India is mainly an agrarian country. Annually it produces more than 500 million tons of crop residues (MoA, 2012). These residues are used as feed, fodder, mulch, for thatching roof, and as a source of domestic and industrial fuel (Bisen and Rahangdale, 2017). Thus they are of tremendous value to the farmers. However, a large portion of unused crop residues are burnt in the fields primarily to clear the left-over crop after the harvest. High cost of residue removal from the field, non availability of labour, and increasing use of combines in harvesting the crops are main reasons behind burning of crop residues in the fields. Burning of residues causes environmental pollution, is hazardous to human health, produces greenhouse gases causing global warming and results in loss of plant nutrients like N, P, K and S. Therefore, appropriate management of crop residues assumes a great significance.

To manage the residues in a productive and profitable manner, conservation agriculture (CA) offers a good promise (Kaur and Grover, 2016). With the adoption of conservation agriculture-based technologies these residues can be used for improving soil health, increasing crop productivity, reducing pollution and enhancing sustainability and resilience of agriculture. The resource conserving technologies (RCTs) involving minimum or zero tillage, direct seeding, bed planting and crop diversification with innovations in residues management are the possible alternatives to the conventional energy and input-intensive agriculture. Permanent crop cover with recycling of crop residues is a pre-requisite and integral part of conservation agriculture. Sowing of a crop in the presence of previous crop residues is a problem. Happy Seeder describes a new approach in solving the problems of direct drilling of seed into heavy crop residues in a single operational pass while retaining the residues as surface mulch (Sandhu *et al*., 2016).

DESCRIPTION OF HAPPY SEEDER

Happy seeder combines the stubble mulching and seed drilling functions into the one machine. It consists of a straw managing unit and a sowing unit in one composite machine. The hinged flails mounted on the rotating shaft cuts the standing stubbles and loose straw coming in front of the furrow opener with simultaneous tyne cleaning (for proper seed placement) and places the residue in between the sowing tynes. This PTO operated machine can be operated with 45 hp double clutch tractors and can cover 0.3 – 0.4 ha/hr.

Happy seeder was developed in 2002 in the department of Farm Power and Machinery in collaboration with CSIRO Land and Water Australia under the financial assistance from ACIAR.The final improvement to this concept came in the form of the 9-row Combo Happy Seeder, developed in 2004, in which the straw handling and seeding functions were combined into a much more compact single machine (Sidhu *et al*., 2007, 2008). A further improvement involved removing some of the straw cutting flails so that only a narrow strip (7.5 cm) of straw in front of the sow-ing tynes was removed. The final version in this series, the Combo+Happy Seeder, also provided the option of strip tillage to improve seed soil contact and thus crop establishment and yield.

Figure 1. Sowing wheat into rice residues with happy seed drill
(Source: Sidhu *et al.,* 2015)

CULTIVATION WITH HAPPY SEEDER

- Field should be leveled for direct drilling of seed so as to ensure uniformity in soil. It helps in achieving uniform depth of seeding and thus helps to get good crop establishment in residue conditions.
- Ensure that the soil moisture at the time of sowing is optimum so as to have uniform crop establishment.
- To obtain good plant stand, crop residue should be uniformly distributed in the field
- Use recommended quantity of seed and adjust the seeding depth between 3.5 to 5.0 cm.
- Seed should be pretreated to control the pests and diseases
- Use double clutch 45 HP tractor to operate the happy seeder.

BENEFITS OF HAPPY SEEDER TECHNOLOGY

- An ecofriendly technology to check air pollution.
- There is no need of pre-sowing irrigation as the sowing of wheat can be done in residual moisture, i.e. saving of one irrigation.
- Timely sowing of crops can be assured even after harvesting of long duration paddy/basmati varieties.
- Saved labour hours per hectare by eliminating land preparation operation before sowing wheat, which in turn reduced fuel and machinery costs.
- Crop residue as mulch helps in moisture and temperature conservation.
- Less weed population (60-70% less) as compared to conventional practice which reduces the cost of production particularly on the use of herbicides.
- Incorporation/retention of crop residue ensure the availability of micro nutrients because their content varies from 70-80% in the crop residue. These are otherwise lost by burning.
- It is less expensive to use than conventional tillage and do not have a negative impact on profitability.

CONSTRAINTS AND CHALLENGES

- Uniform spreading of straw in the combine harvested fields before using the machine
- Machine weight, load on the tractor (requiring 45 hp tractor for operation) and choking of machine under heavy stubble load
- The machine is more expensive which is a key barrier to adoption for the poorer segment of farmers in India.
- Damage of germinating wheat seedlings by rodents and the difficulty of forming bunds in uncultivated fields in the presence of rice residue.
- Lower seeding capacity compared with conventional seed drills.
- Training of contractors and technical staff is essential for proper operation and maintenance of machine.

- A highly dedicated and committed extension effort along with sincere government support are required to popularize this eco-friendly technology for sustainable agriculture on large areas under RW system
- The high levels of dust generated, and leaving one unsown row adjacent to the field boundary due to the rear position of the ground wheel.

CONCLUSION

Happy Seeder is promising technique to mitigate the agrarian crisis by minimal disturbance of the soil by zero tillage, balanced application of chemical inputs and careful management of residues and wastes and at the same time maintaining or increasing yield. This reduces land and water pollution and soil erosion, reduces long term dependency on external inputs, enhances environmental management, improves water quality and water use efficiency, and reduces emissions of greenhouse gases through lessened use of fossil fuels with enhanced productivity and profitability of farmers. It also brings many other benefits including retention of organic matter, suppression of weeds and soil evaporation.

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Crop Need Based Nitrogen Management for Maximizing Crop Yield

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Fertilizer nitrogen (N) has become the key input in food production. Nitrogen plays an important role in synthesis of chlorophyll, amino acids and other organic compounds which contribute to the building units of proteins in the plant system. The photosynthetic activity of the plants and their capacity to utilize available nutrients increases by nitrogen application. It increases the growth, dry matter production and yield of crops even under dry land conditions. Cereals including rice, wheat, and maize account for more than half of the total fertilizer N consumption in the world. As per estimates, 50-70% more cereal grain will be required by 2050 to feed over 9 billion world population. This will further increase demand for fertilizer N at greater magnitude unless the fertilizer N recovery efficiency in cereals is improved. It is only 30–50% by the first crop and not more than 7% by the six consecutive crops (Ladha *et al.,* 2005). When N application is non-synchronized with crop demand, N losses from the soil plant system are large. The generally followed practice of excessive fertilizer N applications to avoid the risk of N deficiency further reduces this efficiency. Excessive N application causes nutrient imbalances and produces plants that are disease and pest susceptible. Low recovery of N is not only responsible for higher cost of crop production, but also for environmental pollution (Fageria and Baligar, 2005). Blanket recommendations based on fixed-time application of fertilizer N doses at specified growth stages do not consider the dynamic soil N supply and crop N requirements, and lead to untimely application of fertilizer N. Therefore, demand driven need based fertilizer N management in crops can help to improve N recovery efficiency and to reduce N losses. In-season, N requirement of crop plants can be accomplished using conventional tissue testing procedures. Monitoring N status of a crop tissue and seasonal N availability has advantages that plant integrates N supply over a period of time, and hence can reflect N supply as affected by weather, soil processing and fertilization. However, plant tissue analysis takes 10-14 days from tissue sampling to receiving a fertilizer recommendation and does not seem to be a practical proposition.

The farmers generally use leaf color as a visual and subjective indicator of the need for N fertilizer (Furuya, 1987). Since farmers generally prefer to keep leaves of the crop dark green, it leads to over application of fertilizers N resulting in low recovery efficiency. Thus, the spectral properties of leaves should be used in a more rational manner to guide need based fertilizer N applications.

The value of soil test prior to planting to evaluate fertilizer requirement for wheat is not well-understood. The soil testing or leaf analyses are expensive and time-consuming. In addition, tissue testing is a destructive method, which limits its use as a diagnostic tool for NUE of cereal plants. The rapid tissue tests for cereal plants are not widely used because critical levels can vary greatly from site to site and can change rapidly over time. Matching crop N demand with flexible, split applications may have economic and environmental advantages above supplying fixed rates at fixed growth stages. In the absence of accurate and rapid N testing methods, many growers currently apply N fertilizer in excess rather than risk yield reduction through N deficiency.

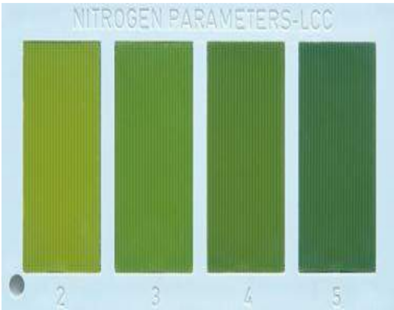
Crop growth and crop need for supplemental N can be strongly influenced by crop-growing conditions, crop and soil management, and climate, which can vary greatly among fields, villages, seasons and years. One of the emerging technologies is the determination of the plant for N status in combination with soil testing. The premise is that the plant may be a better indicator of actual N status than inference from soil test. At the beginning of the season, a fixed N recommendation is given, but crop development and related N needs are strongly influenced by unexpected factors during the growing season. Therefore, the predictive recommendations need to be adapted to the crop N status.

An adequate supply of nitrogen can increase the yield as much as 60%. Top dressing by split application of N is needed when the crop has a great need for N and when the rate of N uptake is large (Dobermann and Fairhurst, 2000). Crop-demand based N application is one of the important options to reduce N loss and to increase N use efficiency of a crop. Chlorophyll meter (SPAD) or leaf colour chart (LCC) can be used for adjustment of fertilizer N application based on actual plant N status (Balasubramanian *et al*., 1999). Need based N application would result in greater agronomic and physiological efficiency of N fertilizer than the commonly practiced method. Ali (2005) revealed that the requirement of N fertilizer based on SPAD reading was found 15 and 40 kg N/ha lower compared to conventional N management during wet and dry seasons, respectively.

Chlorophyll content and nitrogen meters are available to measure light absorption at wavelengths that are sensitive to chlorophyll content in plants. They also measure light absorption in the far red region of the spectrum to measure leaf thickness and the structure of the leaf. These meters do not read out in chlorophyll content directly, but instead, correlate with tissue chemical measurements of chlorophyll content. These instruments are simple enough that they can be used without much training and they can provide a scientifically reliable way to measure and manage nitrogen fertilizer applications. Significant correlations have been observed between chlorophyll content index values obtained with chlorophyll meter and foliar or whole plant N in maize (Bullock and Anderson, 1998). Peterson *et al.* (1993) reported the potential of need based fertilizer N management technology using SPAD meter in maize, SPAD meter was found as helpful guide to regulate the timing of N application (Vetsch and Randall, 2004). Defining a critical SPAD value and to apply N as and when SPAD value fell below the critical limit is the criteria for using chlorophyll meter (Zebarth *et al.,* 2002). For example, in transplanted rice, a SPAD value of 35 was found to be the appropriate threshold for guiding need-based N management (Peng *et al.,* 1996). Several researchers (Murdock *et al.,* 1997; Turner and Jund, 1991 and Yang *et al.,* 2003) have also reported significant coefficients of correlation between grain yield and N concentration in leaves or SPAD values recorded at critical physiological growth stages in rice and wheat. The new CCM-200 has been designed to accurately determine the chlorophyll content in plants and crops. Especially useful for improving nitrogen management programme, the CCM-200 is an ideal instrument for research and teaching. CCM-200 can be used as a substitute for the SPAD 502.

Fig.1 : SPAD 502 plus chlorophyll meter

Inexpensive and practically reliable alternative to the SPAD or CCM meter is the use of Leaf Colour Chart (LCC). It has been successfully used for regulating N supply to rice and wheat (Singh *et al.,* 2007; Singh *et al.,* 2011).



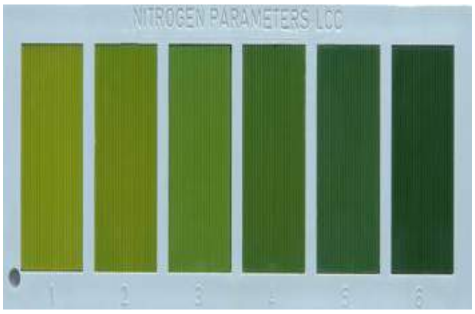


Fig.2 : 4 panel leaf colour chart ***Fig.3: 6 panel leaf colour chart***

The LCC shade 4 on the six-panel IRRI-LCC has been found to be the threshold score for transplanted coarse grain rice varieties prevalent in the Indo-Gangetic plains (Singh *et al*., 2002; Hussain *et al.,* 2003). Several studies (Singh *et al.,* 2011 and Mathukia *et al.,* 2014) had provided evidences for the usefulness of LCC guided need based fertilizer N management technology in assuring high yields and improvement in fertilizer N recovery efficiency in cereal crops. Being a simple and cost-effective gadget it has already penetrated into South Asian farming and increasing numbers of farmers are finding it helpful in efficiently managing N fertilizer in cereals.

CONCLUSION

Nitrogen is the major nutrient limiting the high yield potential of cereals, Farmers generally apply fertilizer nitrogen in several split applications that results in high pest and disease incidence and serious lodging. Precise application of nitrogen fertilizer based on plant need and location in the field greatly improves fertilizer use efficiency in crops. The leaf color chart (LCC) is an easy-to-use and inexpensive diagnostic tool for monitoring the relative greenness of a cereal crops leaf as an indicator of the plant N status. Inexpensive leaf color chart (LCC) has proved quick and reliable tools to decide the time when fertilizer n needs to be applied to the crop. The use of the LCC, farmers can apply N at the right time, thereby increasing the productivity and profitability of cereal crops and reduction of used nitrogen fertilizer.

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Total mixed ration for cattle

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Dairy cow nutrition is very important for milk production and for maintaining proper health. Dairy cow feed should contain concentrates and forages in correct ratio. Adequate amount of vitamins and minerals also should be there. All the nutrients should be supplied and also should be available to the animal. When the nutrients are balanced then only the animals can properly utilize it for better production and other vital functions of the body. Under these circumstances the concept of a single feed that had correct balance of all nutrients is getting importance. Total mixed ration (TMR) is an efficient and effective concept for feeding dairy animals for more profitable and productive purpose. A TMR is a completely balanced ration offered to cows in free choice. TMR feeding is a method of feeding successfully adopted for high yielding shed housed dairy cows all around the world. TMR comprises of forages, grains, protein feeds, minerals, vitamins and feed additives formulated to a specified nutrient concentration into a single feed mix.

Two important things that had to be followed during preparation of TMR feed is that regular testing of forages and other feed samples used in TMR for quality assurance and second thing is that the ration formulations had to be regularly updated based on milk quantity and quality parameters, body weight of animal, moisture conditions in forages and feed ingredients, price of feed ingredients etc. Like every feeding systems, TMR feeding method also had its own advantages and disadvantages.

ADVANTAGES OF TMR

- Feed efficiency improvement is the core advantage of using TMR. Each bite or mouthful of TMR, which the animal consumes, is nutritionally balanced. This provides an adequate environment for the rumen microbes for their efficient functioning. Rumen microbes will be getting regular supply of carbohydrates and proteins for microbial protein production. This finally results in reduced metabolic disorders like acidosis, alkalosis, depressed milk fat, laminitis etc.
- Selective feeding is reduced. Usually if we feed concentrates and forages separately animals had a tendency to eat whatever feed they like. This results in nutritional imbalance and digestive disturbances. In TMR feeding this option of selective feeding got minimized and adds to better feed utilization and efficiency.
- Increase in milk production is noticed upon TMR feeding. Because of better rumen fermentation, absence of metabolic disorders and apt supply of nutrients, milk quality also improves.

- Feeds which are hard to feed separately can be incorporated in TMR feed. So more byproducts and low quality forages can be included which in turn reduces the overall feed cost.
- Labour saving is another important aspect. Feeding concentrates and forages separately will consume more time.
- By knowing the correct amount of daily feed and dry matter intake, feed wastage can be prevented.

DISADVANTAGES OF TMR

- TMR system of feeding is mainly for bigger farms because it is highly effective in group feeding instead of individual feeding. Separate TMR can be developed for different groups like fresh cows, early lactation, mid lactation, late lactation cows and dry cows. But certain disadvantages of group feeding are applicable to TMR feeding also. If a cow is having large variation in milk production or body weight from its group average, then this will result in under feeding or over feeding.
- TMR method of feeding is more expensive since mixers/ blenders are needed for TMR preparation.
- Mixing should be proper because both over and under mixing causes problems. Under mixing causes less feed utilization.
- Chopping of hay/straw is needed for proper mixing sometimes.

TMR FEEDING TIPS

- Chopping of fodder should be given due importance as fine chopping had to be avoided and also grain particles also should not be so coarse. Silage or haylage should have a particle size of ¾ inch.
- Dry matter intake of TMR should be given utmost importance. Low intake of dry matter should be checked and immediate action should be taken to correct the same. Large changes in the dry matter of forages affect the total dry matter of TMR and also intake by animals.
- Groping of animals based on production not only improve the efficiency of TMR feeding but also reduce the feed cost because feeding of expensive ingredients to lower producing cows causes extensive loss to the farmer
- In a big farm ideal grouping can be done as follows

    Lactating animals - High, medium and low producing
    Dry animals - Early and close to calving
    Heifers - Pre and post breeding
    Calves

- The left off TMR not taken by the animals should be only 5%.

CONCLUSION

Now a day it's the time for organized and big farms which needs feeding of animals precisely. Precise nutrition is possible with the help of TMR feeding concept. Organised farms should be converted to TMR feeding concept for improving the production performance of animals and also for economic rearing. While comparing the advantages and disadvantages of TMR feeding, always advantages are staying high. A carefully designed TMR feeding system in farms really payoff a lot. Good management of the farm should be coupled with TMR feeding for better productivity.

Table 1. Ration composition for TMR

Particulars		Crude Protein (% DM)	Concentrate content (% of TMR)	Dry Matter Intake (%BW)	Total NDF (%DM)	Fat (%DM)	Net Energy (Mcal/lb DM)
Lactating animals	**Early**	17-18	55-60	4	28-32	5-7	0.76-0.8
	Mid	16-17	45-50	3.5	33-35	4-6	0.72-0.76
	Late	15-16	35-40	3	36-38	4-5	0.68-0.72
Dry animals	**Early**	12-13	12-15	2	36	-	0.6-0.64
	Close up	13.5-14.5	22-25	1.8	36	-	0.63-0.67

(Source: Modified from Lammers et al., 2014)

Use of Phytochemicals for Management of Insect Pests: A Substitute Approach to Synthetic Chemicals

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Agriculture will increasingly be expected to provide not only food for a world population continuously growing, but also crops for their conversion into renewable fuels and chemical feedstocks. This will further increase the demand for higher crop yields per unit area, requiring chemicals used in crop production to be even more sophisticated (Smith *et al.,* 2008). The large extent, agriculture development has been due to the use of synthetic pesticides to reduce the losses caused by pests. At the same time, some of these products have affected human health and have created environmental and pestresistance problems (Isman,2006). In order to contribute to programmes of integrated crop management, products for plant protection are required to display high effectiveness and specificity, demonstrate benign environmental and toxicological profiles, and be biodegradable (Smith *et al.,* 2008). In the search for alternative solutions to crop protection problems, the interest in plants and their chemo-biodiversity as a source of bioactive substances has increased. Plants are capable of synthesizing an overwhelming variety of small organic molecules called secondary metabolites.Plant produces phytochemicals known active plant-based antifeedants belong to groups like chromenes, polyacetylenes, saponins, quassinoids, cucurbitacins, cyclopropanoid acids, phenolics, alkaloids, various types of terpenes and their derivatives etc so that the same compound may have very different fates and consequences in different insect pests thus different mechanisms involved in antifeedant action. It can also be visualized that insect feeding deterrents may be perceived either by stimulation of specialized deterrent receptors or by distortion of the normal function of neurons, which perceive phagostimulating compounds. Some plant antifeedants influence the feeding activity through a combination of these two principal modes of action. Only a few highly active antifeedants have been looked into from a commercial point of view, which makes it impossible to systemize or to predict any molecular motifs in feeding inhibition. Structure activity relationship studies also do not point to any generalization. “Mix and Match” systems may help in developing a cocktail of feeding inhibitors that can be used in developing a customized formulation against a specific category of pests. Application of suchproducts will be broad to targeted pests and to plant parts. Decreased deterrence resulting from habituation has been suggested that could pose different implications for pest management thandoes decreased deterrence resulting from increased tolerance to toxic substances.

PLANT DEFENSE AGAINST INSECT PESTS

It is well known that phytochemicals are the compounds produced by plants that are not directly involved in growth and development and are traditionally referred to as secondary metabolites. These compounds have been evaluated in the search for new drugs, antibiotics, insecticides, herbicides, and behavior-modifying chemicals. Many of these compounds have been shown to have important adaptive significance in protection against herbivory (Croteau *et al.,* 2000). Phytochemical diversity of insect defenses in tropical and temperate plant families has also been significantly established (Arnason *et al.,* 2004), and this chapter will concentrate on the compounds that interfere with the feeding behavior of insects as well as update and expand the earlier comprehensive compilations (Koul, 2005; Koul, 2011;Isman, 2006). Such feeding behavior-modifying molecules belong mostly to the class of compounds called allomones (Nordlund, 1981), which are differentiated from the pheromones because they mediate interspecific, rather than intraspecific interactions. The tremendous diversity, coupled with the intensity, of allomone-mediated interspecific interactions makes allomonal chemicals potential agents for insect pest control (Koul, 2005). The determination of the molecular basis for action of feeding deterrents in the insect gustatory system is thus a primary goal among basic and applied entomologists interested in insect–plant interactions or in the control of herbivore pests. According to the theory of biochemical coevolution it should be possible to develop an evolutionary pattern of antifeedants on the basis of their distribution in different plant families and their biosynthetic pathways.

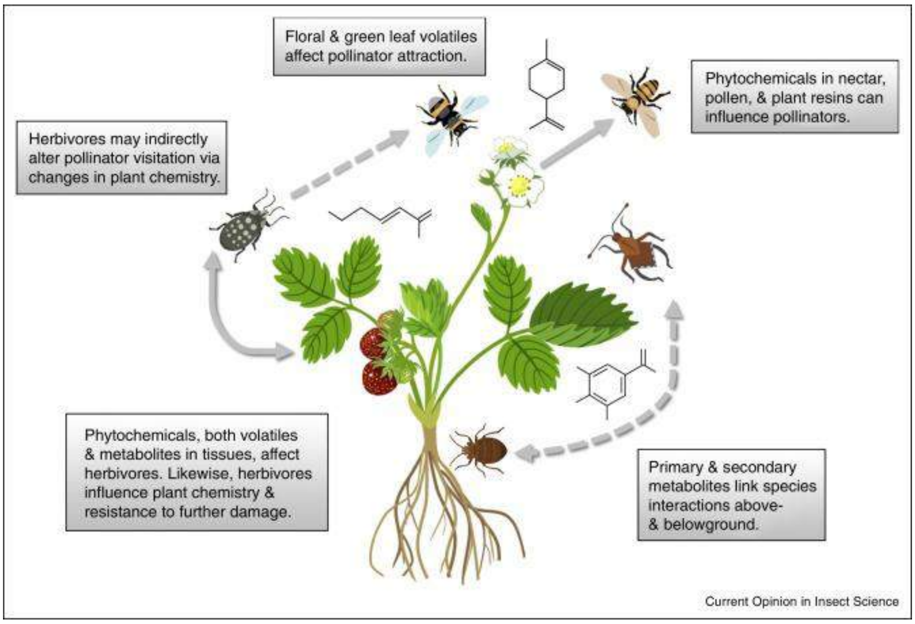

Fig. Interaction of plant and insects (Jamieson *et al.,* 2017)

Since less than 1% of all secondary plant substances, estimated to number 400,000 or more, have been observed against a limited number of insect pest species only, several effective compounds may remain to be discovered. Researchers, when testing candidate compounds, use only a few or even only one species for evaluation. Effective feeding deterrents to a particular insect will easily escape attention. For example, for the well-known antifeedant azadirachtin, tested against seven orthopterans, the interspecific differences span six orders of magnitude. Compounds known as insect antifeedants usually have a more oxidized or unsaturated structure. However, molecular size and shape as well as functional group stereochemistry also affect the antifeedant activity of a molecule. For example, sesquiterpene lactones are defensive compounds and can be divided into two groups based on the stereochemistry of their lactone ring junction, either cis-fused or trans-fused. Stereochemical variation in sesquiterpene lactone ring junctions can influence resistance to herbivorous insects as shown in controlled feeding trials with two pairs of diastereomeric sesquiterpene lactones deterring feeding by the polyphagous grasshopper *Schistocerca americana* (Drury). Sesquiterpene lactone stereochemistry and concentration significantly influenced feeding behavior with grasshoppers consuming less of the *trans*-fused compounds than the cis-fused compounds (Ahern and Whitney, 2014). Stereochemical trait polymorphism is widely distributed in nature and, therefore, could have substantial consequences for the ecology and evolution of large groups of plants, specifically the Asteraceae family. Flavonoids play an important role in the protection of plants against plant-feeding insects and herbivores. Many compounds of this class are known to deter feeding in insects (Mierziak *et al.*, 2014). However, antifeedants can be found among all the major classes of secondary metabolites such as limonoids, quassinoids, diterpenes, sesquiterpenes, monoterpenes, coumarins, alkaloids, maytansinoids, ellagitannins, etc. However, the most potent antifeedants belong to the terpenoid group, which has the greatest number and diversity of known antifeedants. Many such compounds have been comprehensively dealt with earlier (Koul, 2008). Six different indigenous plants were screened for antifeedant and insecticidal activity against fourth instar larvae of *Epilachna* beetle, *Henosepilachna vigintioctopunctata*, which is a severe pest on brinjal. Among the plants screened, *Achyranthes aspera*showed higher activity against the selected pest. Ethyl acetate extracts of *A. aspera*showed higher antifeedant index and insecticidal activity against fourth instar larvae of *H. vigintioctopunctata*. Preliminary phytochemical analysis revealed that the presence of alkaloid and quinines in the ethyl acetate extracts indicate higher percentage of activity. Hence, it may suggest its use for controlling the vegetable insect pest *H. vigintioctopunctata* (Jeyasankar *et al.,* 2014). Ethanol extracts obtained from aerial parts of 64 native plants from central Argentina were tested for their insect antifeedant activity against *Epilachna paenulata* (Coleoptera: Coccinellidae) by choice test. Extracts derived from *Achyrocline satureioides* (Asteraceae), *Baccharis coridifolia* (Asteraceae), *Baccharis flabellata* (Asteraceae), *Ruprechtia apetala* (Polygonaceae)and *Vernonanthura nudiflora* (Asteraceae), showed more than 97% inhibition of the feeding of *E. paenulata* at 100 μg/cm^2. These active extracts were further evaluated for their effectiveness against *Spodoptera frugiperda* (Lepidoptera: Noctuidae). All these extracts, except for that derived from *A. satureioides*, negatively influenced the feeding behavior of *S. frugiperda* at 100 μg/cm^2 (Corral *et al.*, 2014). Similarly, several other plants from Celastraceae, Rhamnaceae, Scrophulariaceae, Menispermaceae, Meliaceae, etc. have also been reported as strong antifeedants.

Antifeedant Potential: Why so Near yet so Far?

Plant based products as safe as compared to synthetic chemicals; thus one can assume that antifeedant compounds are potentially close to us in terms of their eco-friendly environmental and health impacts. This has also provided an impetus for the invention and development of more environmentally benign and less hazardous insecticides. Examination of the scientific research in the field of botanical insecticides covering the past 30 years demonstrates a strong and growing academic interest in this area. However, we achieved the desired goal of inventive and/or commercialization of effective plant-based insect control methods? Unfortunately, the research work so far does not suggest that, and apparently we are yet so far. The rationale for the relevance of chemical characterization or composition should be obvious, for a given plant species, plant defensive chemistry can be highly variable in time and space, and can also be affected by environmental conditions, such as soil type, history of predator,parasitoid and/or pathogen attack, and others (Trumble, 2002; Murtagh and Smith, 1996). Constituents of botanical insecticides will pave the way for a new generation of feeding deterrents that could be applied in a manner that is closer to the natural defense methods used by plants against herbivores.

CONCLUSION

The practice of using feeding deterrents from plant sources allows us to develop and exploit naturally occurring plant defense mechanisms, thereby reducing the use of conventional pesticides. In fact, pesticides derived from plant essential oils do have several important benefits. Due to their volatile nature, there is a much lower level of risk to the environment than with current synthetic pesticides. Predator, parasitoid, and pollinator insect populations will be less impacted because of the minimal residual activity, making essential oil–based pesticides compatible with integrated pest management programs. However, it is advisable to define the goal of research, whether it is the use of crude or semi-refined plant extracts for resource-poor farmers in developing countries, or simply the first step in phytochemical prospecting for new lead chemistries for industrialized pesticide development.

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Climate Smart Agriculture: A Way towards Sustainable Food Security

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Abstract
Food security is both directly and indirectly linked with climate change. By 2050 approximately 70% more food will have to be produced to feed growing populations, particularly in developing countries like India. Due to the climate change and more weather extremes will potentially reduce global food production. Agriculture is badly suffering from these problems. The need to reduce the environmental impacts while increasing productivity requires a significant change in the way agriculture currently operates. 'Climate smart agriculture' has the potential to increase sustainable productivity, increase the resilience of farming systems to climate impacts and mitigate climate change through greenhouse gas emission reductions and carbon sequestration.

Key Words: Climate change, Climate smart agriculture, Food security

Ensuring food security under changing climate conditions is one of the major challenges of this era. There are about 925 million food-insecure people in the world about 16 percent of the population in developing countries. Global population will increase from 7 billion currently to over 9 billion people by 2050, creating a demand for a more diverse diet that requires additional resources to produce. Competition for land, water, and energy will intensify in an attempt to meet the need for food, fodder fuel, and fiber. Various projections suggest that global food requirements must increase by 70 to 100 percent by 2050 (Burney et al., 2010), in addition to maintaining and, where possible, enhancing the resilience of natural ecosystems.

Agriculture is highly vulnerable to climate change and needs to adapt to changing climate conditions. Under optimistic lower end projections of temperature rise, climate change may reduce crop yields by 10 to 20 percent (Jones and Thornton 2009), while increased incidence of droughts and floods may lead to a sharp increase in prices of some of the main food crops by the 2050s. Climate change will also impact agriculture through effects on pests and disease. The interactions between ecosystems and climate change are complex, and the full implications in terms of productivity and food security are uncertain (Gornall et al., 2010)

Climate change impacts on agriculture will have consequences for food security globally. Food security includes four components: availability, stability, access, and utilization of food. Food security is affected by a variety of supply and demand-side pressures, including economic conditions, globalization of markets, safety and quality of food, land-use change, demographic change, and disease and poverty. Within the complex global food system, climate change is expected to affect food security in multiple ways. In addition to altering agricultural yields, projected rising temperatures, changing weather patterns, and increases in frequency of extreme weather events will affect distribution of food- and water-borne diseases as well as food trade and distribution.

Enhancing food security while contributing to mitigate climate change and without deteriorate the natural resources and vital ecosystem services requires the transition to agricultural production systems that are more productive, use inputs more efficiently, have less variability and greater sustainable in their outputs, and are more resilient to risks, shocks and long-term climate variability. More productive and more resilient agriculture requires a major shift in the way land, water, soil nutrients and genetic resources are managed to ensure that these resources are used more efficiently. By reducing greenhouse gas emissions per unit of land and/or agricultural product and increasing carbon sinks, these changes will contribute significantly to the mitigation of climate change.

WHAT IS CLIMATE SMART AGRICULTURE?

Climate-smart agriculture (CSA) is an integrative approach to address these interlinked challenges of food security and climate change, that explicitly aims for three objectives: (1) sustainably increasing agricultural productivity, to support equitable increases in farm incomes, food security and development; (2) adapting and building resilience of agricultural and food security systems to climate change at multiple levels; and (3) reducing greenhouse gas emissions from agriculture (including crops, livestock and fisheries).

What is new about CSA is an explicit consideration of climatic risks that are happening more rapidly and with greater intensity than in the past. New climate risks require changes in agricultural technologies and approaches to improve the lives of those still locked in food insecurity and poverty and to prevent the loss of gains already achieved. CSA approaches entail greater investment in

1. Managing climate risks,
2. Understanding and planning for adaptive transitions that may be needed, for example into new farming systems or livelihoods,
3. Exploiting opportunities for reducing or removing greenhouse gas emissions where feasible.

CSA is an approach to developing the technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. The CSA approach is designed to identify and operationalize sustainable agricultural development within the explicit parameters of climate change.FAO and its partners are aware that achieving the transformations required for CSA and meeting these multiple objectives requires an integrated approach that is responsive to specific local conditions. Coordination across agricultural sectors (e.g. crops, livestock, forestry and fisheries) as well as other sectors, such as with energy and water sector development is essential to capitalize on potential synergies, reduce trade-offs and optimize the use of natural resources and ecosystem services. To address this complex task and support member countries, FAO's different departments have worked together to articulate the concept of CSA. In carrying out this work, the Organization provides guidance about the practices; technologies, policies and financing that are required to achieve a productive, resilient and sustainable agriculture sector.

CSA is not a single specific agricultural technology or practice that can be universally applied. It is an approach that requires site-specific assessments to identify suitable agricultural production technologies and practices.

Table 1. Climate-smart practices useful in agricultural production

Crop management	Livestock management	Soil and water management	Agroforestry	Integrated food energy systems
1.Intercropping with legumes 2. Crop rotations 3.New crop varieties (e.g. drought resistant) 4.Improved storage and processing techniques 5.Greater crop diversity	1. Improved feeding strategies (e.g. cut n carry) 2. Rotational grazing 3.Fodder crops 4. Grassland restoration and conservation 5. Manure treatment 6. Improved livestock health 7. Animal husbandry improvements	1. Conservation agriculture (e.g. minimum tillage) 2. Contour planting 3.Terraces and bunds 4.Planting pits 5.Water storage (e.g. water pans) 6.Alternate wetting and drying (rice) 7.Dams, pits, ridges 8. Improved irrigation (e.g. drip)	1.Boundary trees and hedgerows 2.Nitrogen-fixing trees on farms 3.Multipurpose trees 4.Improved fallow with fertilizer shrubs 5.Woodlots 6. Fruit orchards	1.Biogas 2.Production of energy plants 3. Improved stoves

IMPACTS OF CLIMATE CHANGE ON AGRICULTURE:

Agriculture is sensitive to short-term changes in weather and to seasonal, annual and long term variations in climate. Crop yield is the culmination of a diversified range of factors. Parameters like soil, seed, pest and diseases, fertilizers and agronomic practices exert significant influence on crop yield. The burgeoning population, along with human-induced climate change and environmental problems is increasingly proving to be a limiting factor for enhancing farm productivity and ensuring food security for the rural poor. Climate change has already significantly impacted agriculture (Lobell et al., 2011) and is expected to further impact directly and indirectly food production. Rise in mean temperature; changes in rainfall patterns; depletes water table; the frequency and intensity of droughts and floods; sea level rise and salinization, all will have profound impacts on agriculture, forestry and fisheries (Gornall, 2010; IPCC, 2007a; Beddington, et al,. 2012; HLPE, 2012; Thornton et al.., 2012).

Some predict positive impacts on agriculture from climate change like increased temperatures and higher carbon dioxide levels. Increased concentrations of CO_2 may boost crop productivity, only where moisture is not a constraint. For rice, the amylase content of the grain-a major determinant of cooking quality-is increased under elevated CO_2. With wheat, elevated CO_2 reduces the protein content of grain and flour by 9-13%. Concentrations of Fe and Zn which are important for human nutrition would be lower.

According to A K Singh, deputy director-general (natural resource management) of the Indian Council of Agricultural Research (ICAR), medium-term climate change predictions have projected the likely reduction in crop yields due to climate change at between 4.5 and 9 per cent by 2039. The long run predictions paint a scarier picture with the crop yields anticipated to fall by 25 per or more by 2099. With 27.5% of the population still below the poverty line, reducing vulnerability to the impacts of climate change is essential. Indian food production must increase by 5 million metric tons per year to keep pace with population increase and ensure food security. Coping with the impact of climate change on agriculture will require careful management of resources like soil, water and biodiversity. To cope with the impacts of climate change on agriculture and food production, India will need to act at the global, regional, national and local levels.

IMPACTS OF AGRICULTURE ON CLIMATE CHANGE

Modern agriculture, food production and distribution are major contributors of greenhouse gases. Agriculture is directly responsible for 14 per cent of total greenhouse gas emissions, and broader rural land use decisions have an even larger impact. Deforestation currently accounts for an additional 18 per cent of emissions. Dr. Rattan Lal, Professor of Soil Science at Ohio State University, has calculated that over the last 150 years, 476 billions of tonnes of carbon has been emitted from farmland soils due to inappropriate farming and grazing practices, compared with 'only' 270 Gt emitted from of burning of fossil fuels. A more frequently quoted figure is that 200 to 250 Gt of carbon have been lost from the biosphere as a whole in the last 300 years.

The main direct sources of GHG emissions in the agricultural sector are not only carbon dioxide (CO_2). Agriculture is a source of nitrous oxide (N_2O), accounting for 58 percent of total emissions, mostly by soils and through the application of fertilizers, and of methane (CH_4), accounting for 47 percent of total emissions, essentially from livestock and rice cultivation. These emissions are dependent on natural processes and agricultural practices, which makes them more difficult to control and measure. On the other hand, agriculture is a key sector that, along with the forestry sector, if managed effectively can lead to biological carbon capture and storage in biomass and soil, acting as "sinks". Their management can play an essential role in managing climate change (IPCC, 2007b), especially in the long term.

CONCLUSIONS

No one really knows the nature of what the future holds with regard to climate change. Addressing food security and climate change challenges has to be done in an integrated manner. To increase food production and to reduce emissions intensity, thus contributing to mitigate climate change, food systems have to be more efficient in the use of resources. To ensure food security and adapt to climate change they have to become more resilient. However, the best way in which the community can cope with climate change and food security is to become less vulnerable to change. Education is seen as the key, in which knowledge provides the understanding of how to do things better. So rather than teaching about problems which might lead to confusion and concern, the focus is on encouraging people to choose practices that improve their lives, reduce resource consumption, restore ecosystem functioning and hence services, and mitigate carbon footprints.

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Bio-fertilizers and its importance in Agriculture

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The increasing population puts considerable pressure on land and other natural resources of the world causing damage to the ecological base of agriculture and serious socio-economic problems. The increased crop production over years has accelerated the removal of plant nutrient four times during the last four decades putting fourfold pressure on soil resources. The replenishment of nutrients lost in crop removal through the use of chemical inputs is not considerable advise as their use on a long run has been found to decelerate the biological activities in the soil causing impaired soil health, consequently, increasing awareness is being created in favors of Organic farming which has emerged as an important priority area globally in view of the growing demand for safe and healthy food and long term sustainability and concerns on environmental pollution associated with indiscriminate use of agrochemicals.

Microorganisms plays an important role in the service of mankind, ranging from fermented foods and beverages to transformation of plant nutrients. They are being exploited since long by the food and beverage industry. However, their use in agriculture is relativetly recent. Besides development of biofertilizer for nitrogen fixation and P-solubilization/mobilization, considerable work has been done on biopesticides for the control of plant diseases, pests, weeds and detoxification of industrial waste using soil microorganisms. Biofertlizers are biologically active products containing live microorganisms on a suitable carrier used to inoculate seed or soil or both for improving plant nutrients, stimulating plant growth, accelerating decomposition of plant residues. The importance of biofertilizers is due to accruing of larger benefits relatively ti the costs involved, recycling of plant nutrients and their environment friendly nature.

Use of biofertilizers helps in mobilizing plant nutrients through the activity of organisms contained in it. If these organisms are not present in adequate numbers in soil, they have to be inoculated by using biofertilizers to get the desired effect.

WORKING PRINCIPLES OF BIO-FERTILIZER

- Biofertilizers fixed atmospheric nitrogen in the soil and root nodules of legume crops and make it available to the plant.

- They solubilise the insoluble forms of phosphates like tricalcium, iron and aluminium phosphates into available forms.
- They scavenge phosphate from soil layers.
- They produce hormones and anti metabolites which promote root growth.
- They decompose organic matter and help in mineralization in soil.
- When applied to seed or soil, biofertilizers increase the availability of nutrients and improve the yield by 10 to 25% without adversely affecting the soil and environment.

TYPES OF BIOFERTILIZERS

Biofertilizers include the following types:
1. Symbiotic Nitrogen Fixers Rhizobium spp.
2. Asymbiotic Free Nitrogen Fixers (Azotobacter)
3. Azospirillum
4. Algae Biofertilizers (Blue Green Algae or BGA in association with Azolla).
5. Phosphate Solubilising Bacteria.
6. Mycorrhizae.

S.no	Groups	Examples
N2 Fixing Bio-fertilizers		
1.	Free-living	*Azotobacter, Beijerinkia, Clostridium, Klebsiella, Anabaena, Nostoc*
2.	Symbiotic	*Rhizobium, Frankia, Anabaena azollae*
3.	Associative Symbiotic	*Azospirillum*
P Solublizing biofertilizers		
4.	Bacteria	*Bacillus megaterium* var. *phosphaticum, Bacillus subtilis Bacillus circulans, Pseudomonas striata*
5.	Fungi	*Penicillium sp, Aspergillus awamori*
P- Mobilizing Biofertilizers		
6.	Arbuscular mycorrhiza	*Glomus sp.,Gigaspora sp.,Acaulospora sp., Scutellospora sp. & Sclerocystis sp.*
7.	Ectomycorrhiza	*Laccaria sp., Pisolithus sp., Boletus sp., Amanita sp*
8.	Ericoid mycorrhizae	*Pezizella ericae*
9.	Orchid mycorrhiza	. *Rhizoctonia solani*
Biofertilizer for micronutrient		
	Silicate and Zinc solubilizers	*Bacillus* sp.
Plant Growth Promoting Rhizobacteria		
Pseudomonas		*Pseudomonas fluorescens*

1. **Rhizobium**

Among biofrtilizers, Rhizobium are of greatest importance because of their ability to fix atmospheric N2 in association with certain legumes. It is estimated that N2 fixation by Rhizobium in root nodules of legumes is of the order of 14Mt on a global scale and almost 15% of industrial N_2 fixation (88Mt). it is now known that yield of many leguminous crops can be stepped- up substantially by the use of appropriate Rhizobium cultures. Rhizobium bacteria live in the root nodules of legume plants through a symbiotic relationship. There are six distinct species under genus Rhizobium which is classified on the basis of cross inoculation group concept. The assumption of this concept is that those legumes falling within a particular infection group can be inoculated by a particular species of nodule bacteria.

2 **Azotobacter**

Azotobacter fixes atmospheric N2 non- symbiotically and the extent of fixation is directly dependent upon the amount of carbohydrates utilized by them. It is an aerobic, chemoheterotrophic and freeliving bacterium. Hence, they work better in the root region of crop non-symbiotically when adequate organic matter is present. They are very effective in enhancing yield of crops like wheat, rice, sorgam, etc. and vegetable crops like onion, brinjal, tomato, cabbage etc.

3 **Azospirillium**

Azosprillium is a chemoheterotrophic bacteria associated to live within the roots of sorghum, pearl millet, rice, maize, wheat and sugarcane crops. They fixes atmospheric N2 to the extent of about 15-30kgN/ha.

4 **Frankia**

It shows symbiotic association with certain non-legumes, mainly with trees and shrubs. It has modest agricultural importance because its potential in fixing N from atmosphere is not widely known. However, its potential could be harnessed in agroforestry.

5 **Azolla**

Azolla is known as free floating water fern. Azolla fixes atmospheric N2 in symbiotic association with blue green algae in rice fields. This association is a live, floating N2-factory using energy from photosynthesis to fix atmospheric N2, amounting to 40-60kgN/ha/rice crop. Azolla contains 0.2-0.3% N on fresh weight basis and 3-5%N on dry weight basis. There are seven species of Azolla out of which Azolla pinnata is most widely distributed in india. Azolla can be used both as green manure before transplanting and as a dual crop after transplanting of rice.Azolla supplies N to rice after its decomposition just like any other organic matter. It takes about 8-10 days to decompose and release about 67% of its N with in 35 days.

6. **Blue green algae**

BGA are also known as cynobacteria. The first account of agronomic potential of BGA in rice was presented by P.K.De ,who attributed the natural fertility of tropical rice filed to these N2 fixing organisms. The N2 fixing potential of BGA can be estimated by evaluating its biomass. N- content and N2 fixing activity. Nitrogen fixed by BGA becomes available to the rice crop after their decomposition available to the rice crop after their decomposition as the case with Azolla or any organic sources.BGA can contribute about 20-30kgN/ha.

7. **Phosphate Solubilizing Microorganisms**

A group of heterotrophic microorganisms possess the ability to solubilize inorganic P form insoluble sources to soluble forms. They may be efficient strains of bacteria, namely Bacillus megaterium, B. polymyxa, B. subtilis, B. circulance, Pseudomonas striata, etc, fungi, namely Aspergillus awamori, A. niger, Penicillium digitatum, Trichoderma sp.

The principal mechanism for mineral phosphate solubilization due to inoculation with PSM is the action of organic acids like citric, oxalic, tartaric, acetic, lactic, gluconic, etc. produced by microorganisms. These acids are sources of H+ ions and are able to dissolve the mineral phosphate and make it available to the plant. In addition to pH reduction, organic acids anions can solubilize phosphate through chelation reactions. Organic acid anions through their hydroxyl and carboxyl groups , have the ability to form chelates with cations such as Ca++, Fe++, Fe+++, Al+++, that are often bound with phosphate, the latter being converted to soluble forms. In addition to p- solubilization, these microorganisms can mineralize organic P into a soluble form. The reaction takes place in the rhizosphere and because the microorganisms render more P into solution than is required for themselves for their own growth and metabolism, the surplus is available for plants.

8. **Vesicular-arbuscular Mycorrhiza**

The symbiotic association between plant roots and fungi is termed as mycorrhizal association which is known to improve the growth and yield of crops in nutrient-deficient conditions. There are two types of mycorrhiza, namely ectomycorrhiza and endomycorrhiza. VAMfungi fall under endomycoorhiza group. These are obligate symbiont with a network of hyphea in soil and extensive growth within the plant roots.they have an important role in efficient use of P-fertilizers and improving N2-fixation. VAM fungi infect the palnts, spread inside the root and produce highly branched hyphal structure, knoen as vesicles and arbuscules, with in the host cells. The arbuscules, with in the transfer of nutrients from the fungus to the root systems and the vesicles store P as phospholipids. Mycorrhizal association is generally found very effective in agroforestry. The other crops where VAM infections have shown beneficial effects are sorghum, barley, wheat, rice, tobacco, cotton, soyabean, cassava, grape etc. Mycorrhizzal roots can take up several times more per unit root length than non-mucorrhizal roots, primarily because of larger surface area resulting from the growth of hyphae. Mycorrhizal infection can also increase the uptake of nutrients like K, particularly in seedlings of forest trees and S, Cu, Zn.

Liquid Bio-fertilizers (Break through in BFTechnology)

Liquid bio-fertilizers are special liquid formulation containing not only the desired microorganisms and their nutrients but also special cell protectants or chemicals that promote formation of resting spores or cysts for longer shelf life and tolerance to adverse conditions. (Hegde, 2008). Bhattacharyya and Kumar (2000), states that, biofertilizers manufactured in India are mostly carrier based and in the carrier-based (solid) bio-fertilizers, the microorganisms have a shelf life of only six months. They are not tolerant to UV rays and temperatures more than 30 0C. The population density of these microbes is only 108 (10 crores) c.f.u/ml at the time of production. This count reduces day by day. In the fourth month it reduces to 106 (10 lakhs) c.f.u/ml and at the end of 6 months the count is almost nil. That's why the carrier-based biofertilizers were not effective and did not become popular among the farmers. These defects are rectified and fulfilled in the case of Liquid bio-fertilizers. The shelf life of the microbes in these liquid bio-fertilizers is two years. They are tolerant to high temperatures (55 0C) and ultra violet radiations. The count is as high as109 c.f.u/ml, which is maintained constant up to two years. So, the application of 1 ml of liquid bio-fertilizers is equivalent to the application of 1 Kg of 5 months old carrier based bio-fertilizers (1000 times). Since these are liquid formulations the application in the field is also very simple and easy. They are applied using hand sprayers, power sprayers, fertigation tanks and as basal manure mixed along with FYM etc.

Table2. Biofertilizers and their host crops , method of application and rate of inoculants used.

Name of organism	Host crops for which used	Method of application	Rate of inoculent
Rhizobium strian	Legumes like puses, soyabean, groundnut	Seed treatment	200g per 10kg seed
Azotobacter	Cereals, millets, cotton, vegetables	Seed treatment	200g per 10kg seed
Azospirillium	Non-legumes like maize, barley, oats, sorghum, millet, sugarcane	Seed treatment	200g per 10kg seed
Phosphate solubilizers	Soil application for all crops	Seed treatment	200g per 10kg seed
Azolla	Rice	Soil application	10kg/ha
Mycorrhiza	Many treespecies, wheat, sorhum	Soil application	1t dried material/ha

ADVANTAGES OF USING BIOFERTILIZERS IN AGRICULTURE:

1. It is a low cost and easy technique.
2. The biofertilizers increase 15-35% additional yield in most of vegetable crops.
3. Besides fixing atmospheric nitrogen, cyanobacteria synthesize and excrete several growth hormones (auxins and ascorbic acid) and vitamins which enhance seed germination and growth of crop plants.
4. They do not cause atmospheric pollution and increase soil fertility.

5. Some biofertilizers excrete antibiotics and thus act as pesticides.
6. They improve physical and chemical properties of soil such as water holding capacity, buffer capacity etc.
7. Some of the biofertilizers enhance crop yield even under ill irrigated conditions where chemical fertilizers are of not much advantage.
8. They are ecofriendly and pose no danger to the environment

METODS OF APPLICATION OF BIOFERTILIZERS

Seed treatment: For treating seeds, 200g of Biofertilizers is suspended in 300-400ml of water and mixed gently with seeds (10 kg) using an adhesive like gum acacia, jiggery solution etc, so that the bioinoculents may get energy for their prolonged survival. Care should be taken to avoid any damage to seed coat. The seed are then spread on a clean sheet/ cloth under shade to dry and used immediately foe sowing.

Seedling Root Dip: For rice crop, a bed is made in the field and filed with water. Recommended biofertilizers are mixed in this water and the roots of seedlings are dipped for 8=10h and transplanted.

Soil treatment : Four kilogram each of the recommended biofertlizers is mixed in 200kg of compost and kept overnight. This mixture is incorporated in the soil at the time of sowing or planting.

CONCLUSION

Biofertilizers increase the availability of plant nutrients and can help in maintenance of the soil fertility over a long period. As discussed earlier, some microorganisms have the beneficial role of biological nitrogen fixation to supply nitrogen to crops, solubilizing insoluble phosphates to plant-available (soluble) forms and synthesizing biomass for manuring of crops like rice. Biofertilizers are, therefore, economical, renewable and eco-friendly, but they cannot totally replace chemical fertilizers. Biofertilizer use is an important component of Integrated Nutrient Management and organic farming. These technologies are becoming vital in modern-day agricultural practices. The changing scenario of agricultural practices and environmental hazards associated with chemical fertilizers demand a more significant role of biofertilizers in coming years.To improve and maintain the productivity of agricultural lands, the integrated approach to determine the most favorable plant-microorganism interaction is vital. The current trend of low input chemicals in sustainable agricultural systems will contribute to the goal. As a boon for farmers, Bio-fertilizers being essential components of organic farming play vital role in maintaining long term soil fertility and sustainability. Bio-fertilizers would be the viable option for farmers to increase productivity per unit area in organic farming for an era of prosperity and clean environment.

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Vermicomposting: An Easiest Technique of Recycling Organic Wastes

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Abstract

Vermicomposting is the easiest technique of recycling organic wastes to enriched compost with the use of earthworms. Earthworms consume biomass and excrete it in digested form called casts. It is brownish black, stable, fine granular in texture. The casts are rich in nutrients, growth promoting hormones (auxin, cytokine and gibberellins), humic acids, beneficial organisms including plant growth promoting rhizobacteria and having properties of inhibiting pathogenic organisms. A typical nutrient analysis of vermicompost is pH 6.8, organic matter 20.46 %, C:N ratio 12:1; 1.02 % total nitrogen; 0.50 % available nitrogen; 0.30 % available phosphorus; 0.24 % available potassium; 0.17 % calcium and 0.06 % magnesium. It improves physic-chemical and biological properties of soil and promotes plant growth and development. Due to its multipurpose property, the appeal of vermicompost is welcomed in organic farming and sustainable agriculture practices. The N content can be enhanced by supplementing the organic wastes with cow urine and vermicompost can be harvested at least 10-15 days earlier. Generally, animal manure (cow dung), crop residues (rice straw), green weeds, tree leaves, banana stems, kitchen waste, vegetable waste, sawdust etc. are used as raw materials in vermicomposting technique. Epigeic species (Eisenia fetida, Eudrilus eugeniae and Perionyx excavates) are used in this technique. It is a mesophilic process and faster than traditional composting. It takes about 45-60 days to complete a cycle and finished product is 3/4th of the raw materials used. It is assumed that around 5–6 cycles of production can be completed with duration of each cycle at around 60 days. One can get benefits from sale of vermicompost @ Rs. 3500 - 5000 per tonne and worm @ Rs. 300-500 per kilogram.

Vermicomposting is a technique of preparing enriched compost with the use of earthworms. It is one of the easiest techniques to recycle organic wastes to quality compost. Earthworms consume biomass and excrete it in digested form called worm casts. The casts are rich in nutrients, growth promoting substances, beneficial soil microorganisms and having properties of inhibiting pathogenic microbes. It is stable, fine granular in texture, which improve physicochemical and biological properties of soil. It is highly useful in raising seedlings and crop production. Worm casts are popularly called as Black gold. Vermicompost is becoming popular as a major component of organic farming system. Vermicompost is a simple biological process of composting, in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product. It is a mesophilic process, utilizing microorganisms and earthworms that are active at 10–35°C. The process is faster than conventional composting, because the material passes through the earthworm gut, a significant transformation takes place, whereby the resulting earthworm casts are rich in microbial activity and plant growth regulators and also mysteriously it has pest repellence attributes as well. Vermicompost is similar to conventional compost, except that it uses worms in addition to microbes to turn organic wastes into a nutrient-rich manure. *Eisenia fetida, Eudrilus eugeniae* and *Perionyx excavatus* are some of the species that are used to convert organic wastes into vermicompost.

TRADITIONAL COMPOSTING AND VERMICOMPOSTING

Vermicomposting (Latin vermes = worm) is a kindred process to composting, featuring the addition of certain earthworms species to enhance the process of waste conversion and produce an enriched compost. Vermicomposting differs from traditional composting in several ways. Chiefly, vermicomposting is a mesophilic process, utilizing microorganisms and earthworms that are active in a temperature range of 10-35 ^{0}C (temperature within the pile of moist organic material). The process is considered faster than composting, because material passes through the earthworm gut, a significant transformation takes place, whereby the resulting earthworm castings are abundant in microbial activity and plant growth regulators and fortified with pest repellence attributes as well. Vermicomposting is compatible with environment friendly that value conservation of resources and sustainable practices. Both systems utilize microbial activity to break down organic matter in a moist, aerobic environment. However vermicomposting requires greater surface area, more moisture, and is susceptible to heat, high salt levels, high ammonia levels, anaerobic conditions and pungent substances that may be toxic to earthworms (onion wastes, raddish wastes etc). Traditional thermophilic composting relate to: long duration of the process, frequent turning of the material, material size reduction to enhance the surface area, loss of nutrients during the prolonged process and the heterogeneous resultant product. However, the main advantage of thermophilic composting is that the temperatures reached during the process are high enough for an adequate pathogen kill. In vermicomposting, the earthworms take over both the roles of turning and maintaining the material in an aerobic condition, thereby reducing the need for mechanical operations. In addition, vermicompost is homogenous. However, the major drawback of the vermicomposting process is that the temperature is not high enough for an acceptable pathogen kill. Whereas in traditional thermophilic composting the temperatures exceed 70 °C, the vermicomposting processes must be maintained at less than 35 °C. Limiting factors for vermicomposting include insufficient water supply, extremely cold weather conditions, poor quality materials, poor management of worm beds, limited surface area, and lack of suitable species of earthworms to begin process.

VERMICOMPOST AND PLANTS

Vermicompost consists mostly of worm casts (poop) plus some decayed organic matter. In ideal conditions worms can eat at least their own weight of organic matter in a day. In fact they don't actually eat it, they consume it and mysteriously their casts contain eight times as many micro-organisms as their feed. And these are the microorganisms that best favour healthy plant growth. The casts don't contain any disease pathogens, pathogenic bacteria are reliably killed in the worms' gut. This is one of the great benefits of vermicomposting. Worm casts also contain five times more nitrogen, seven times more phosphorus, and eleven times more potassium than ordinary soil, the main minerals needed for plant growth. It contains large numbers of beneficial soil micro-organisms. The casts are also rich in humic acids, which condition the soil, have a perfect pH balance, and contain plant growth hormones (such as auxin, cytokine, gibberellins). On applying to the field, it boosts the growth of plants. Thats why, the demand of vermicompost is increasing especially in onganic farming and high value crop cultivation.

VERMICOMPOST CHARACTERISTICS:

(i) Nutrients

The nutrient content of vermicompost varies with type of organic wastes. Mineralization of nitrogen, phosphorous and sulphur is taken place in the earthworms gut after egestion. A typical nutrient analysis of vermicompost is pH 6.8, organic matter 20.46 %, C:N ratio 12:1; 1.02 % total nitrogen; 0.50 % available nitrogen; 0.30 % available phosphorus; 0.24 % available potassium; 0.17 % calcium and 0.06 % magnesium (**Table 2**). The slow-release granules structure of casts allows nutrients to be released relatively slowly in harmonize with plant needs.

(ii) Salinity.

Ammonium is the main contributor to salinity levels in casts. Earthworms are repelled by salinity levels above 5 mg/g. Therefore, feeding material should be salt free; the resulting vermicast will be as well.

(iii) Pathogens

Pathogen levels are low in vermicast than in typical composts. Vermicast is low in pathogens because earthworms consume fungi, and aerobic bacteria do not survive low oxygen levels in the gut. Another reason is that vermicasting does not build up heat, which allows disease-suppressing organisms to survive in earthworms gut and compete with pathogens. Vermicompost protects cucumbers from *Pythium aphanidermatum*, a seed-infecting pathogen.

(iv) Digestion

Red wigglers (*Eisenia foetida*) can consume of their body weight (0.2 g) per day. Earthworms require oxygen and water, both exchanged through their skin. As organic matter passes through the earthworm gut, it is mineralized into plant nutrients. During mineralization process ammonium is produced and after egesting it is nitrified. The grinding effect of its gizzard and the effect of its gut muscle movement result in the formation of casts.

(v) Feed Preferences

Ideally, earthworm feed has a C:N ratio 25:1 and a pH between 6.5 – 8.0, 60-75% moisture content. Beyond optimum pH repel earthworms. Ideal earthworm feed is: porous, allowing oxygen to penetrate worm, worms can survive in temperatures 0°C–35°C, but at lower temperatures they are not as active and die at freezing temperatures.

(vi) Light Sensitivity

Earthworms have eye-cells on their skin that trigger pain when exposed to any light but blue light, keeping them underground during daylight. They will search to any material if a light is shining at the surface of the material.

(vii) Drainage and Aeration

For proper drainage and aeration, bed bottom and side walls must be made of a perforated material. Many commercially available vermicomposting beds are concreted and have a few holes at the bottom for drainage. Starting with a layer of sand and a layer of bedding material (mixture of fertile soil plus cow dung) at the bottom provides room for worm. During mixing and turning beds are aerated. Leachate (vermiwash) draining through holes can be collected, stored in container and reintroduced to the bed.

(viii) Moisture

Waste materials should have a moisture content of 60-75%. Regular watering or automatic sprinkling in the case of large scale systems, is usually needed. If waste materials are wet such as fruits and vegetables waste (about 90% moisture), watering is not necessary, and drainage will correct the moisture level.

(ix) Thickness of the waste layer

To prevent anaerobic conditions, which can result in fermentation and heat build-up, design the vermicomposting bed: raised bed or windrow pile to keep the waste layer at a thickness of 30 cm (1 ft) or less. This thickness allows air to diffuse into the material, aided by the canals burrowed by earthworms. This keeps the pile aerated and cool, which earthworms prefer.

(x) Temperature

Since earthworms require a temperature range of 10°C–35°C (optimum is 25°C), year-round vermicomposting systems must be designed carefully. The system can be installed in a shaded location to control temperature fluctuations.

(xi) Odours and Flies

Odorous gases (volatile organic compounds) and heat are generated from poorly aerated (anaerobic) organic materials. This is often a problem in compost beds if they are not aerated or turned out. However, earthworms thrive in aerobic conditions, where heat and odours do not occur. The process produces slight pungent odours and attacks flies due to present in excess moisture.

The worms

Earthworms are epigeic (surface dwellers), endogeic (burrow up to 15 cm deep) or anecic (burrow vertical channels, about 1 m deep). They live in garden soil called red worms, tiger worms, brandlings, angle worms, manure worms, or red wrigglers, they occupy a different ecological niche, living near the surface where there are high concentrations of organic matter, such as on pastures, leaf mould or under compost piles. Of the 4,400 identified earthworm species, specific species of litter-dwelling earthworms are required for this process. They are classified as epigeic earthworms, they are more pigmented than the other species. There are about 350 species of earthworms in India with various food and burrowing habits. *Eisenia foetida* (Red earthworm), *Eudrilus eugeniae* (night crawler) and *Perionyx excavatus* are some of the species used in vermicomposting. They are surface feeder and convert organic wastes into compost from upper surface. Red earthworm (Epigeic) is preferred because of its high multiplication rate and thereby converts the organic matter into compost within 45-60 days. *Lumbricus rubellus* (red worm) and *Eisenia foetida* are thermo-tolerant and so particularly useful. Field worms (*Allolobophora caliginosa*) and night crawlers (*Lumbricus terrestris*) attack organic matter from below but the latter do not thrive during active composting, being killed more easily than the others at high temperature. European night crawlers *(Dendrabaena veneta* or *Eisenia hortensis)* are produced commercially and have been used successfully in moist climates. The African night crawler (*Eudrilus eugeniae*), is a large, tropical worm species. It tolerates higher temperatures than *Eisenia foetida* does, provided there is ample humidity. However, it has a narrow temperature tolerance range and dies at temperature below 7 ^{0}C.

Table 1. Important characteristics of red earthworm (*Eisenia foetida*)

Character	***Eisenia foetida***
Body length	3-10cm
Body weight	0.4-0.6g
Maturity	50-55days
Conversion rate	2.0 q/1500worms/2 months
Cocoon production	1 in every 3 days
Incubation of cocoon	20-23days

FEEDING HABIT OF EARTHWORMS

Earthworms can consume practically all kinds of organic matter and they can eat their own body weight per day, e.g. 1 kg of worms can consume 1 kg of residues every day. As organic matter passes through the intestine of earthworm, it is mineralized into plant nutrients. During mineralization process ammonium is produced and after egesting it is nitrified. The grinding effect of its gizzard and the effect of its gut muscle movement result in the formation of casts. The excreta (cast) of the worms are rich in nitrate, available forms of P, K, S, Ca, Mg and micronutrients. Earthworms are epigeic (surface dwellers), endogeic (burrow up to 15 cm deep) or anecic (burrow vertical channels, about 1 m deep). Epigeic earthworms such as *Eisenia foetida* (red wigglers) are the best adapted to ingest organic wastes. The passage of soil through earthworms promotes the growth of bacteria and actinomycetes. Actinomycetes thrive in the presence of worms and their content in worm casts is more than six times that in the original soil.

BREEDING AND MULTIPLICATION

Earthworms are capable to multiply rapidly, where conditions are optimal. Earthworm takes about six weeks to reach reproductive phase. Mature red worms lay 1-2 egg capsules a week, each producing 2-7 hatchlings after about three weeks. The hatchlings are tiny white threads about half an inch long, but they grow fast, reaching sexual maturity in 4-6 weeks and making their own capsules. Three months later they are grandparents. Thus, the multiplication of worms under optimum growth conditions is very fast. The worms live for about 2 years. Sufficient scientific study has neither confirmed nor denied that earthworms proliferate in exponential rates of growth. Their casts are slightly toxic to them and they migrate to lower layer. It makes it easier to harvest the higher proportion of pure casts. A moist compost heap of 2.4 m ×1.2 m 0.6 m size can support a population of more than 50,000 worms.

Worm beds

Normally the beds/pits have 0.3 – 0.9 m height depending on the provision for drainage of excess water. Care should be taken to make the bed with uniform height over the entire width to avoid low production owing to low bed volumes. The bed width should be 1.0 – 1.5 m to allow easy access to the centre of the bed/pits. Length can be taken as required as depend on production. The system would have at least 6-12 sheds for convenience and a dedicated area for finished products. It should also have a water provision.

TECHNIQUES OF VERMICOMPOSTING

There are various methods of vermicromposting technique, among them bed and pit methods are more common in India.

(i) Bed method: In this technique vermicomposting is done on the pucca/kachcha floor by making bed (6×2×2 feet size) of feed mixture. This method is easy to maintain and to practice.

(ii) Pit method: Composting is done in the cemented pits of size 6×3×3 feet with sloping sides. The unit is shaded from hot sunshine with thatch grass, rice straw or any other locally available materials. In this method care should be taken for better aeration and water logging at bottom.

Following procedure is followed for vermicomposting technique:

- Vermicomposting unit should be in a cool, moist and shady place
- Cow dung and chopped dried organic materials are mixed in the proportion of 2 : 1 and are kept for partial decomposition for 15 days.

- A layer of 15-20 cm of chopped dried organic materials should be kept as bedding material at the bottom.
- Beds of partially decomposed material of size 6×2×2 feet should be made.
- Each bed/pit should contain 1.5-2.0 q of raw material and the number of beds can be increased as per raw material availability and requirement.
- Red earthworm of 1.0-1.5 kg (1000-1500) should be released on the upper layer of bed.
- Water should be sprinkled with can immediately after the release of worms.
- Beds should be kept moist by sprinkling of water (daily) and by covering with gunny bags.
- Bed/pits should be turned once after 20-30 days for maintaining better aeration and for proper decomposition.
- Compost gets ready in 45-60 days.
- The finished product is 3/4th of the raw materials used.

PREVENTIVE MEASURES

- The floor of the unit should be compact to prevent earthworms' migration into the soil.
- 15-20 days old cow dung should be used to avoid excess heat.
- The organic wastes should be free from pungent residues, plastics, chemicals, pesticides and metals etc.
- Four side of the unit should be covered with net to prevent bird entry.
- Aeration should be maintained for proper growth and multiplication of earthworms.
- Optimum moisture level (30-40 %) should be maintained
- Optimum temperature of 18-25 ^{0}C should be maintained for proper decomposition.

Raw materials required

Generally raw materials used in vermicomposting are animal manure (cow dung), crop residues (rice straw), green weeds, tree leaves, banana stems, kitchen waste, vegetable waste, sawdust etc. Among them cow dung and rice straw are most commonly used in vermicomposing technique.

Equipments required

Generally equipments required in vermicomposting unit are Spade, Shovel, Rake, Water sprayer, Trolley, Sickle, Sieve (3 wire mesh sieves- 0.6 m × 0.9 m size), Gunny bag, Polythene, Bucket, Weighing machine, Jute rope, Measuring tape, Packaging machine, Vermiwash collection container, Jug, Bamboo buskets, Water provision etc.

Enhancing vermicompost production

Vermicompost production using epigeic compost worms such as *Eisenia foetida*, *Lumbricus rubellus* and *Eudrilus eugeniae* can be enhanced effectively by supplementing the organic wastes used for vermicomposting with cow urine. Undiluted urine can be used for moistening organic wastes during the preliminary composting period (before the addition of worms.). After the initiation of worm activity, urine can be diluted with an equal quantity of water. No problems have been observed with daily use of diluted cow urine for moistening the vermicomposting bed. This simple technique can yield vermicompost with a higher N content. Moreover, worms have been found to become very active and vermicompost can be harvested at least 10-15 days earler.

VERMICOMPOST AND ORGANIC FARMING

Most individuals of fertilizer industries would have little knowledge about vermicomposting. vermicompost is vastly different from petro-chemical fertilizers which have detrimental effects on biological life in the soil. On the other hand, vermicompost is enriched in available nutrients, growth promoting hormones (auxin, cytokine, and gibberellins), beneficial organisms including plant growth promoting rhizobacteria and having disease suppressing properties. It improves physic-chemical and biological properties of soil and promotes plant growth and development. It is the easiest source of enriched manure for nutrients supplementations in organic agriculture. Due to its multipurpose property, the appeal of vermicompost is welcomed in organic farming and sustainable agriculture practices.

Harvesting

First procedure- When raw material is completely decomposed it appears brownish black and granular. Watering should be stopped as compost gets ready. The compost should be kept over a heap of partially decomposed cow dung so that earthworms could migrate to cow dung from compost. After two days, compost can be separated and sieved for use.

Second procedure- The castings formed on the top layer is collected periodically. The collection may be carried out once in a week. With hand or shovel the castings are scooped out and heap in a shady place. The harvesting of casting should be limited up to earth worm presence on top layer. This periodical harvesting are for free flow and retaining the compost quality. The harvested vermicompost are sieved through a mesh sieve to separate any earth worm present on casts. Besides, there may some other waste material are separated from the vermicompost. Then it is ready for use.

Nutrient content

The level of nutrients in compost depends upon the source of the raw material and the species of earthworm. A fine worm cast is rich in N P K besides other nutrients. Nutrients in vermicompost are in readily available form and are released within a month of application (**Table 2**).

Table 2. A typical nutrient analysis of vermicompost

Parameter	Content
pH	6.8
OC%	11.88
OM%	20.46
C/N ration	11.64

Total Nitrogen (%)	1.02
Available N (%)	0.50
Available P (%)	0.30
Available K (%)	0.24
Ca (%)	0.17
Mg (%)	0.06

Recommended doses

The doses of vermicompost application depend upon the type of crop grown in the field/nursery. For fruit crops, it is applied in the tree basin. It is added in the pot mixture for potted ornamental plants and for raising seedlings. Vermicompost can be used as in organic production system and as a component of integrated nutrient supply system (Table 3).

Table 3. Recommended doses of vermicompost

Crops	Dose/rate
Field crops	5-6 t/ha
Fruit crops	3-5 kg/plant
Pots	100-200 g/pot

Economics

It is assumed that there will be around 2-3 cycles of production in the first year and 5-6 cycles in the subsequent years with duration of each cycle at around 60-70 days. Further, taking into account various limitations and operational problems, the capacity utilization is further assumed at 50% in the 1st year and 90% from 2nd year onwards. Benefits include the income from sale of vermicompost @ Rs. 3500 - 5000 per tonne and worm @ Rs. 300-500 per kg and it may be higher depending on demand from region to region.

ADVANTAGES

- There are many advantages of vermicompost :
- It provides efficient conversion of organic wastes/crop/animal residues.
- It is a stable and enriched soil amendment.
- It helps in reducing population of pathogenic microbes.
- It helps in reducing the toxicity of heavy metals.
- It is eco-friendly and environmentally safe
- It is a nutrient supplement system for organic food production.
- It is an easily adoptable low cost technology.

PROBLEMS AND SOLUTIONS

- **Bad smell**-worm casts have a pleasant, earthy smell, like forest soil. Sometimes bad smell comes out due to overloading the system. To remove the smell stir turn out the bed/pit with the hand rake.
- **Ants-** regular inspection is needed to prevent ants.
- **Mites-** the best prevention for red mites is to make sure that the ph stays at neutral or above. This can be done by keeping the moisture levels below 85% and through the addition of calcium carbonate, as required.
- **Centipedes-** they can be destroyed by means of a hand-held propane torch or something similar.
- **Birds-** putting a windrow cover or four-sided covering the shade eliminate the bird entry.
- **Moles-** it can be prevented by putting a wire mesh, paving, or a good layer of clay under the windrow.
- **Flies-** due to present in excess moisture. Proper drainage at the bottom of the beds resolves this situation.

Production Technology of Cucurbits in Riverbeds

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Abstract

It is old practice of growing vegetables on the bank or basin of rivers. River areas are called "Diara". *Diara* land cultivation continues to be carried out with the traditional manner. Riverbed cultivation is a kind of vegetables forcing, facilitating off season production of mainly cucurbitaceous vegetables. Sowing is done for early crop: 1st – 2nd week in November, late crop 1st week January. Mixed cropping is usually practiced in riverbeds. Usually these lands are available only for a short period and landless, small and marginal farmers and cultivate the cucurbitaceous vegetables on these lands for marketing. Musk melon and water melon generally go together. Other cucurbits generally grown together are bottle gourd, cucumber, summer squash, bitter gourd, Indian squash or round melon *(tinda*), long melon (*kakri*) in north India, ridge gourd in Rajasthan, MP, and UP. The dry leaves and stems of *Saccharum* (Sarkanda) are planted in the northern sides of the trenches to protect the young seedlings against chilling injuries/frost in December and January.

Key Words: Cucurbitaceous Vegetables, *Diara* cultivation, Riverbed farming

INTRODUCTION

It is old practice of growing vegetables on the bank or basin of rivers. River areas are called "Diara". *Diara* land cultivation continues to be carried out with the traditional manner. Riverbed cultivation is a kind of vegetables forcing, facilitating off season production of mainly cucurbitaceous vegetables. In survey it was observed that out of total area under cucurbits cultivation, 60 % area is under riverbed cultivation during the summer season around 75-80 % of total cucurbits production is being produced in diara land area which is available in market from February – June (Anonymous, 2014). In south Asia, cucurbit vegetables are extensively grown in riverbeds. They are known as *diara* lands. This world alludes to the Hindustani word *dia* mening lamp, i.e., bowl-like land on either side of the riverbank or even between the dharas or small streams. Such land is also known as in different areas of India as *khaddar* lands, *char* lands, *dariayi, kachhar,* riverine area, and *nadiari. Diara* lands are formed due to alluvion and diluvion action of perennial rivers, and consequently, have varied types of deposition. The soil profile normally contains fine to coarse sand layers. There are certain areas in eastern U.P. and Bihar called *tal* lands. They are vast stretches of flood plains, that is, land flooded by overflow of the rivers during the rainy season. Such lands have good drainage (Nayar and More, 1998)

The chemical properties of soils of Gomti and Sarayu *diaras* in Faizabad district, U.P. are almost neutral. Their initial fertility status is poor with respect to Phosphorus (Sharma and Krisnamohan, (1989). The soil of Ganga *diara* are also almost neutral in reaction, but they are relatively more fertile than the soil of Sarayu *dirara. Diara* areas are classified into three groups (Anonymous, 1974; Singh, 1977). On the basis of location.

a) The main riverbed consists of sand. It is available for cultivation from December to June. The vegetables grown are Water melon, Musk melon, Pumpkin, Bottle gourd and Bitter gourd.
b) The main *diara* lands are located on the beds of rivers. It is frequently inundated by swollen flood water.
c) Upland *diara* is the result of continuous deposition. It is elevated land .It is less frequently and not much different from non-*diara* lands.

In india, the main riverbeds were cucurbits are grown occur on the rivers Sabarmati, Vatrak, Panam, Orusung, MAahi, Banas, and Tapti in Gujrat; Narmada, Tapti, Tawa, and Mohan in Madhya Pradesh: Markheda ghat and Banas in Rajasthan. Ghaghra, tank beds, Sharda, Ramganga and Gomti in U.P. Tugbhadra, Krishna, Pennar, Papagni, Hundri in Andhra Pradesh: Tapti, Burai, Purna, Vagur, Girna, Mais Bhuikund, Nirguna and Kanhan in Mharashtara; and Ganga, Gandak, Sone, Kosi, and Burhi Ganga in Bihar (Anonymous, 1980).

IMPORTANCE OF RIVERBED CULTIVATION

- Early, and high yield
- Ease in irrigation
- High net return per unit area
- Additional crop
- Low cost
- Less weed growth
- Control of disease and pest is very easy by cultural methods.
- Cheap availability of labour.

CULTIVATION

Land Preparation: Under riverbed cultivation, pits or trenches are made during October-November. They are convenient length, 30 cm wide and 60 cm deep or to a depth at which the sand is moist. A distance of nearly 2-3 m is kept between the trends. Trends are filled with well rotten FYM (cattle manure, farm yard manure), which is mix in the soil. All the cucurbits are sensitive to acid soils. Below pH of 5.5 no cucurbits can be successfully grown and most of the cucurbits prefer a soil pH between 6.0 to 7.0. Musk melon is slightly tolerant to soil acidity, while other cucurbits prefer intermediate or normal pH. (Patel *et al.,* 2016).

Sowing methods: Three or four pregerminating seeds are planted per hill in pits or trenches. The seeds are pregerminated by soaking of seeds for 12-24 h in water.
Sowing season: Early crop: 1st – 2nd week in November, late crop 1st week January.
After care: Planting of Saccharum grass: protection from the sun during the day, and to function to look-out during the night and also protect against chilly wind.
Manure and fertilizers:
No systematic work has been done on the fertilizer requirements of riverbed-grown cucurbitaceous crops. (Purewal, 1957) recommended the application of 30-60 g ammonium sulphate per pit at the time of thinning. Nagabhushanam (1973) observed that manuring is generally done in stages, when the seedlings are about 10, 25, and 45 days old. The first application consists of FYM and groundnut and caster cake. Subsequent application contains ammonium sulphate and silt, in addition to FYM. River silts are generally used to enhance retaintivity of moisture in the feeding zone.

IMPROVED VARIETIES FOR RIVERBED CULTIVATION

Diara land cultivation continues to be carried out with the traditional varieties and manner. Many improved varieties of bottle gourd, bitter gourd cucumber, luffa etc. have been developed by various research institutes but they yet to be evaluated and adopted in diara lands cultivation (Patel *et al*., 2016). A list of landraces of muskmelon grown in different states of India is given in Table 20.

States	District	Varieties
Uttar Pradesh	Lucknow	Lucknow safeda, Kanpur local
	Unnao, Kanpur	Jogia, Mathuria
	Allahabad	Allahabad Kajra
	Jaunpur , Varanasi	Jaunpuri Netted, Jametha
	Varanasi,Azamgadh,	Mau
	Faizabad	Mau
	Meerut	Bhagpat
	Agra	Mau
Maharashtra	Dhulia	Goose, Jam, Neel
Rajasthan	Jaipur	Sanganer
Karnataka	Mandya	Kadapa
Haryana	Sonepat,Kurukshetra	Kutana, Bhagpat
Punjab	Amaritsar , Bhatinda	Haridhari , Musa
Gujrat	Barodra	Sunkheda type

Sources: (Nayar and More, 1998)

CROPPING PATTERN

Mixed cropping is usually practiced in riverbeds. Musk melon and water melon generally go together. Other cucurbits generally grown together are bottle gourd, cucumber, summer squash, bitter gourd, Indian squash or round melon *(tinda*), long melon (*kakri*) in north India, ridge gourd in Rajasthan, MP, and UP (Anonymous, 1980), and pointed in Bihar (Dubey and Pandey,1973).

Riverbed cultivation

Cultivation of cucurbitaceous vegetables in off-season: under the riverbed or diara system.

The riverbeds or diara are lands alongside the river streams which occupied 7,000 ha alongside river Yamuna in NCR Delhi. The cucurbitaceous vegetables like melons, cucumber, pumpkin, squashes and gourds can be cultivated successfully in 0ff-season (winter).quality seeds of improved varieties and hybrids of these crops are sown during Nov.- Dec. in the bottom of trenches prepared east to west at 2 to 3 meter spacing. The dry leaves and stems of *Saccharum* (Sarkanda) are planted in the northern sides of the trenches to protect the young seedlings against chilling injuries/frost in December and January. The pot irrigation is practiced in the initial stages of germination and growth till the roots of the plants touch the water regime below the sand. Harvesting of fruits starts in the month of Feb.- March (off-season) and give early yield and higher return. (Selvakumar, 2014)

Pests and Diseases:

In the early stages of germination and growth, red pumpkin beetles and aphids are more common. Most of farmers do not spray any insecticide while some do spray dimethoate and dimecron in Haryana and AP. Among the diseases, powdery mildew and downy mildew are important. Virus diseases are more common in most states. Among the viruses, cucumber green mottle mosaic virus (CGMMV) is the most common (Nayar and More, 1998).

CONCLUSION

Riverbed cultivation continues to be carried out in the traditional manner. Farmers are using their own produced seed and due to cross pollination in cucurbits some time fruits coming from river beds are of undependable quality. Fruits from river bed cultivation are available 30-50 days before than the normal field sown crop hence farmer get very high price of their produced. The improvement of landraces should be done through simple methods of selection and maintenance will give quick and durable result. The locally adopted varieties are accepted by farmers. The Multiplication and distribution of seed of such landraces are should be done by Horticultural Research Institute/SAUs /Local agricultural, horticultural departments in nearby experiment station.

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Various models to calculate chill units in fruit crops

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Abstract

Different temperate and subtropical fruit crops grown in different parts of the world requires chilling temperature for certain period of time to break bud dormancy. Non availability of favourable chilling temperature results in non flowering. Various models such as chilling hours model, Utah model and dynamic model have been developed to assess the effective chill temperature and duration for various fruit crops.

Keywords: Chilling, dynamic model, fruits, Utah model

INTRODUCTION

Chilling requirement is defined as the number of effective chilling hours needed to restore bud growth potential in spring (Richardson *et al*., 1974). Chilling refers to the physiological requirement of low temperature to allow normal spring growth, and failure to obtain sufficient winter chilling results in a marked decline in both yield and fruit quality. The chilling requirement is typically measured in terms of numbers of hours, during which temperature remains at or below 7°C during the winter season. Winter chill is a necessary factor for deciduous fruits in temperate climates so that latent buds can break the state of winter recess or endodormancy (ED) and begin growing during the spring (Saure, 1985; Lang, 1987).

IMPACT OF INADEQUATE CHILLING

Temperate fruits are mainly produced in the middle latitudes ranging from 30° to 50° N and S. Their cultivation may extends to lower latitudes (15°-30° N and S) at higher altitudes and to higher latitudes where large water bodies and congenial climate is available. In India, the study on seasonal and annual surface air temperature has shown a significant warming trend of 0.57°C per hundred years (Pant and Kumar, 1997). The global warming caused loss of vigour, fruit bearing ability, reduction in size of fruits, less juice content, low colour, reduced shelf-life and increasing attack of pests resulting in the low production and poor quality apple crop (Jangra and Sharma, 2013). The chill units critical for apple production have exhibited a decreasing trend. Trend analysis indicated that snowfall is decreasing at the rate of 82.7 mm/ annum in the entire region of Himanchal Pradesh (Gautam *et al*., 2014), consequently, the apple cultivation area is moving further up in elevation because of the warmer climate.

MODELS TO CALCULATE CHILL UNITS

1. Chilling hours model

The Chilling Hours Model is the oldest method to quantify winter chill (Chandler, 1942). According to this model, temperatures between 0°C and 7.2°C are assumed to have a chilling effect, with each hour at temperatures between these thresholds contributing one chilling hour. Chilling hours are thus accumulated throughout the dormant season and then summed up (Luedeling, 2012)

2. Utah model

The Utah Model developed in Utah, USA. It contains a weight function assigning different chilling efficiencies to different temperature ranges, including negative contributions by high temperatures. This model of chill units (CU) defines a CU as the permanence of the buds for a period of 1 hour in a temperature range considered optimum (2.5-12.5°C) to accumulate chill.

The Utah model is more complex because it introduces the concept of relative chilling effectiveness and negative chilling accumulation (or chilling negation). According to Richardson *et al*. (1974) temperatures between 0 and 16 ˚C promote the breaking of rest, whereas temperatures > 16EC negate such effects. Maximum promotion occurs at 7 ˚C (1 h at 7 ˚C = 1 chill unit); higher and lower temperatures within the 0-16 ˚C range are less effective.

The model is defined as:

1 hour below 34 ˚F = 0.0 chill unit
1 hour 34.01 – 36 ˚F = 0.5 chill unit
1 hour 36.01 – 48 ˚F = 1.0 chill unit
1 hour 48.01 – 54 ˚F = 0.5 chill unit
1 hour 54.01 – 60 ˚F = 0.0 chill unit
1 hour 60.01 – 65 ˚F = -0.5 chill unit
1 hour > 65.01 ˚F = -1.0 chill unit

The model presumes that chill accumulation occurs within a temperature range of 2.5 and 12.5°C, outside of which, the accumulation is nil or negative (Richardson *et al*., 1974). This model, although it gives good results in cool and cold temperate climates, yields a large quantity of negative chill values in sub-tropical climates and because of this its utilization and applicability have been limited (Dennis, 2003). A modification of this model consists of not considering the negative values of the Utah model, because of which it has been termed the model of Positive Chill Units (PCU) and its application in these sub-tropical zones has improved the results obtained (Linsley-Noakes *et al.*, 1995).

3. Dynamic model

The Dynamic Model was developed in Israel (Fishman, 1987). It calculates chill in units known as ‘chill portions’, based on hourly temperatures. According to the Dynamic model, effective winter chill temperatures follow a bell shape with an optimum chilling temperature at 6 °C, tapering to zero at −2 °C and 14 °C. High temperatures act to negate previously accumulated chill and moderate temperatures can enhance chill accumulation.

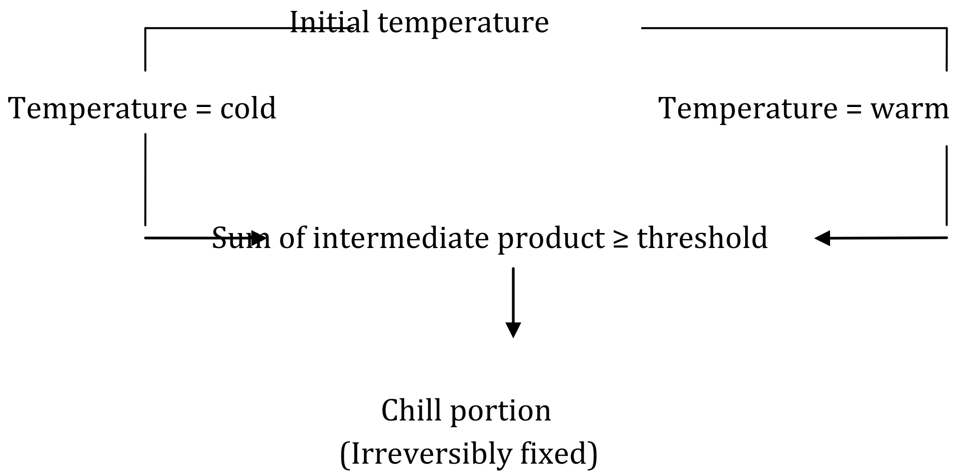

Fig 1. Schematic representation of the Dynamic model (Darbyshire *et al*. 2011)

An intermediate product is produced through exposure to effective winter chill temperatures. This intermediate product can be destroyed by subsequent exposure to high temperatures. Once a threshold amount of this intermediate product is amassed it is irreversibly banked as a chill portion (fig 1). Summing chill portions over autumn and winter provides an estimate of accumulated winter chill. This complex model adds a further element of timing of exposure to temperatures in a cycle and appears to be far more accurate under warm winter conditions.

CONCLUSION

Several models of winter chill have been developed using the observed effects of temperature on dormancy breaking. The Chill Hours model was the first to be developed and estimates winter chill based on hourly temperatures. This is a ‘yes–no’ model with temperatures between 0–7.2 °C allocated 1 chill hour (yes) and temperatures outside of that interval allocated a 0 chill hour (no). These chill hours are summed over autumn and winter to give an estimate of total winter chill. Knowledge of temperature effects on winter chill has since expanded and the Dynamic chill model is the current best practice model. It calculates chill in units known as ‘chill portions’, based on hourly temperatures. The Dynamic model has many features which capture known temperature-winter chill relationships which are lacking in other models including the Chill Hours model.

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Moringa: Alternative fodder for livestock

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India has enormous livestock population in the world, which is growing annually at the rate of 4.8%. Accordingly, requirement of the feed for livestock is also increasing. In the tropics there is a growing scarcity of green fodder for livestock, which is one of the major constraints to increased livestock production, particularly during the dry season. Currently, the country faces a net deficit of 35.6% green fodder, 10.95% dry fodder and 44% concentrate feed ingredients. During this period most of the farmers rely on the use of different crop residues and low quality hay to feed their animals. Feeding of these crop residues leads to low digestibility and low voluntary intake as these crop residues are low in nitrogen and high in lignocellulose.

In such scarcity areas, multipurpose trees could be a good option to meet the fodder demand of livestock and can be used as cheap supplementary feeds for the livestock. Research studies have stated that these multipurpose trees could provide alternative source of nutrition for ruminants in tropics. Among such trees *Moringa oleifera* is becoming popular because of its high nutritional profile and medicinal properties. It is a native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan and is planted around the world.

Moringa *oleifera* is member of the *Moringaceae* family, it is a fast growing tree and can tolerate draught, sandy soil, bacteria and fungi, and thrives in subtropical to tropical dry to moist climates. Almost every part of the plant is nutritious specially its leaves are a rich source of highly digestible protein, calcium, iron , and vitamin C, essential for livestock. Beside these, the plant is also rich in vitamin B-complex, chromium, copper, magnesium, manganese, phosphorus and zinc. Since Moringa leaves are rich in protein, so can be used as a supplemental fodder for milch animals. Rather, its leaves contain much higher protein than conventional protein supplements like coconut meal, cotton seed cake, ground nut cake, sesame cake, sunflower cake etc. Besides these, the leaves posses antioxidant and antimicrobial properties.

Forage yield:

Moringa has an outstanding growth and can be harvested for foliage in less than 2.5 months. Optimal cutting intervals range from 15 to 75 days, depending on local conditions. In the rainy season, harvesting the crop at an interval of 4 to 6 weeks at a height of 150 cm gives the highest yields. In the dry season 12 week harvest interval gives highest biomass yields with a cutting height of 100cm. An average 4.2 to 8.3 t ha-1 dry matter yield can be obtained. Up to 9 cuttings/year could be done.

Nutrient composition:

Moringa leaves are usually considered as source of protein. However, the protein content range from 15% to more than 30% DM as it depends on the stage of maturity and on the fodder's respective proportions of leaflets, petioles and stems, the latter being much poorer in protein. Likewise, the fibre content of moringa leaves reported in the literature is extremely variable, with an ADF content ranging from 8% to more than 30% DM. Lignin content is also variable, from 2% to more than 10% DM. Moringa leaves contain high levels minerals (about 10% DM), particularly Ca and Fe. Moringa leaves contain high amounts of a wide range of vitamins (ß-caroten, ascorbic acid, vitamin B1, B6 and niacin) which are known to be more potent antioxidants than ascorbic acid.

Moringa seed cake

Moringa seed cake defatted with a solvent is a high-protein ingredient containing about 60% DM of protein, with limited amounts of fibre (NDF 9% DM) and fat (less than 1%). Its amino acid profile is rich in sulphur-containing amino acids (methionine + cystine: 6.1% of protein) but very poor in lysine (less than 1.5% of protein).

Table: Chemical composition and nutritional value of *Moringa oleifera* fresh leaves

Sr. No	Attribute	Average (% DM)
1	Dry matter	26.2 (% As feed)
2	Crude protein	24.3
3	Crude fibre	13.6
4	NDF	28.3
5	ADF	19.3
6	Lignin	7.0
7	Ether extract	5.4
8	Ash	10.3
9	Gross energy	18.6

(Source: https://www.feedipedia.org)

Effect of feeding of Moringa Fodder on Growth & Milk Yield in livestock:

Moringa leaves are readily eaten by cattle, sheep, goats, pigs and rabbits. Dairy animals like cows, buffaloes, if supplemented with green leaves and stems of moringa, produce 43-65 per cent more milk. Cattle fed on moringa leaves also show rapid gain in weight. Research studies have shown that the inclusion of moringa as a protein supplement to low quality diets improved dry matter intake and digestibility of the diet and increased milk production without affecting the milk composition.

Moringa diet had the highest efficiency of protein utilization, nutrient digestibility, nitrogen utilization. It improves the milk yield of ruminants as it has a good rumen bypass protein characteristics. In fact, MLM can be used as a substitute for other oil cakes (soybean and rapeseed meals), and they are able to improve the microbial protein synthesis in the rumen.

However, the fodder should be mixed with molasses, sugarcane, young elephant grass, sweet (young) sorghum plants, or whatever else is locally available. The high protein content of moringa leaves must be balanced with other energy food. Care must be taken to avoid excessive protein intake as too much protein in a cattle feed can be fatal.

Anti-nutrients in *moringa oleifera*

Moringa leaves are free from anti-nutrients except for saponins and phenols. The concentration of phenol is much below the toxic threshold levels for animals and saponins were inactive as far as haemolytic properties are concerned. Alkaloids are also present in kernel meals (root-bark)have been found to have two alkaloids, moringine and moringinine; moringinine is known to stimulate cardiac activity, raise blood-pressure, act on sympathetic nerve-endings as well as smooth muscles all over the body, and depress the sympathetic motor fibres of vessels in large doses only.

CONCLUSION

Moringa oleifera is the most useful trees as feed supplements to animals as their leaves are highly nutritious with excellent palatability, digestibility and balanced chemical composition of protein and minerals. Even though currently *Moringa olifera* is spread almost world-wide, there is scanty information on its potential as an animal feed.

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Maternal Dystocia in bovines: an overview

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Abstract

When the cause of dystocia lies with the dam, it is known as maternal dystocia. Maternal causes of dystocia include defects in tubular genital tract of dam or its bony pelvis. Among defects in the genital tract, important are strictures or soft tissue obstructions in the vulva and vagina, incomplete dilation of cervix, uterine torsion and displacement of uterus. Pelvic defects include fracture of pelvis or narrow pelvis in heifers. Excessive deposition of peri-vaginal fat may also narrow down the birth canal. Among these conditions, the incidence of uterine torsion is very high in buffaloes and is a single major cause of maternal dystocia in certain parts of India.

1. Uterine Torsion

Uterine torsion involves the rotation of uterus along its longitudinal axis. It mostly occurs in animals with complete gestation and is specifically a complication of first stage or early second stage of parturition. The incidence of uterine torsion varies from country to country, species to species and even from breed to breed. The incidence is more in buffaloes as compared to cows. The exact cause for uterine torsion is still obscure. However, certain factors like heavy pendulous abdomen in buffaloes, sudden slipping or falling, walking down or up the hill, wallowing, imbalanced pregnant uterus, abrupt fetal movements near term and weak broad ligaments predispose to uterine torsion. Uterine torsion can lead to spontaneous vaginal rupture, uterine rupture, peritonitis, rotation of urinary bladder or formation of adhesions with surrounding viscera thereby leading to heavy mortality of fetuses and the dam.

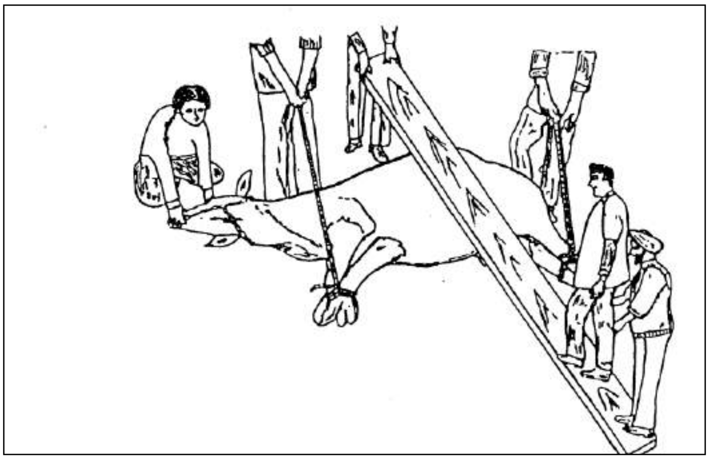
Site and side of uterine torsion

The torsion of uterus can occur at body of uterus (pre-cervical uterine torsion), cervix, or may involve vagina (post-cervical uterine torsion). It can be clockwise (right side) or anti-clockwise (left side). Degree of torsion may vary from less than 45 to more than 360, though 180° right side uterine torsion is most common in buffaloes.

Diagnosis

Site and side of uterine torsion can be assessed by per-vaginal and per-rectal examinations**.** In post-cervical uterine torsion, on per-vaginal examination, the hand will not touch the cervix and the direction of rotation of hand will reveal the side of uterine torsion while in pre-cervical uterine torsion the cervix will be palpable per-vaginally. Per-rectal examination reveals the stretched broad ligaments that can help confirm the side of uterine torsion. In right side uterine torsion, left broad ligament will be stretched over the body of uterus and right broad ligament will be stretched below the body of uterus making a pouch on the right side. In left uterine torsion the right ligament will be stretched over and the left ligament will be below the uterus. The degree of torsion can be assessed from the fold of uterine body on per-rectal examination.

Treatment



A number of methods like abdominal ballotment, per-vaginal rotation of fetus and laparotomy have been suggested, but Sharma's modified method has been found to be the best to achieve detorsion of uterus in buffaloes. In this method, the dam is casted and rotated in the direction of uterine torsion. The fetus is fixed in position by external pressure of a plank kept in inclined manner on the abdomen of the animal with 2-3 persons standing on the end touching the ground while one person modulates the pressure on the end of plank away from the ground. It is highly successful if the case is fresh (presented within 36 h of the development of torsion). If the case is moderately delayed (presented within 36-72 h), the success of detorsion is significantly reduced and fetal delivery may be achieved in 50 per cent cases only due to failure of cervical dilation. Majority of cases, which are more than 72 h old, may require cesarean section due to development of utero-omental adhesions.

2. Uterine Rupture

Uterine ruptures mostly occur during handling of dystocia due to faulty use of instruments or injuries by sharp bony prominences created during fetotomy. Uterine ruptures may prove fatal due to excessive bleeding or seepage of infected uterine fluids into the peritoneal cavity leading to peritonitis and death of the animal.

Diagnosis

Uterine rupture can be diagnosed during per-vaginal and/or per-rectal examination. Breathing in such animals may be labored due to exhaustion and excessive loss of blood.

Treatment

The tears on the dorsal side of genitalia are not very dangerous because of limited chances of seepage of uterine fluids into the peritoneal cavity. Hence, ecbolics like oxytocin which cause uterine contractions may be used so as to near the torn ends of the uterus. Larger tears especially on the lateral and ventral side need suturing which can be done per-vaginally or after inducing the uterine prolapse. However, this needs careful handling of the fragile tissue.

3. Displacement of uterus

Sometime in advanced pregnancy due to rupture of the abdominal muscles, the uterus is displaced through the hernia. This is characterized by an acute abdominal swelling usually on the right ventral side. The pregnancy is not affected but often due to extreme ventral displacement, normal delivery of the fetus does not occur. In such cases, delivery is to be assisted.

4. Defects of bony pelvis

Fracture of the bones of pelvis usually the shaft of ileum, results into callous formation or improper joining leading to narrowing down of the pelvic inlet or outlet that results into dystocia. Heifers, which conceive at a lower age, are still growing and have narrow pelvis that results into dystocia due to feto-pelvic disproportion.

Diagnosis

Pelvimetry and per-vaginal examination can help to predict the state of narrow pelvis

Treatment

Depending upon the pelvic volume, fetotomy or cesarean section is performed. However, small fetus can also be delivered through mutations without fetotomy or cesarean section.

5. Vulvar and vaginal stricture

The stricture or narrowing of vulva and vagina can occur due to healing of lacerations and tears during previous parturition or handling of dystocia. These can be diagnosed at per-vaginal examination, however, no definite treatment is yet available. Hence, attempt should be to avoid or minimize injuries to the genital tract.

6. Soft tissue obstructions

These occur due to development of tumors or cysts. Pedunculated (benign) tumors can be removed surgically. There is no successful treatment yet standardized for diffused tumors.

7. Incomplete cervical dilatation

Cervix in ruminants is a hard structure consisting of 3 – 5 fibrous annular rings that cannot be dilated manually. During late pregnancy and first stage of parturition, the cervix undergoes several structural changes and dilates under the effect of hormones

(Estradiol, Relaxin, Prostaglandin), so as to facilitate easy delivery of the fetus. However, once the concentration of estrogens starts receding, it contracts irrespective of fetal delivery (secondary contraction). Secondary contraction of cervix has no treatment and usually the fetus is delivered by cesarean section. During primary contraction of cervix (cervix fails to dilate due to hormonal imbalance) some hormones like prostaglandin (parentral or intracervical), estrogens or glucocorticoids may be tried. To hasten the cervical dilation, Valethmate bromide can also be injected parenterally. Hypocalcemia may be one of the causes for incomplete cervical dilation that is characterized by weak uterine contractions. Care must be taken to decide about the time period to wait before it is decided to manipulate such a case. Prolonged wait can result into entry of bacteria and development of uterine infections leading to fetal maceration.

Impact of post-partum uterine infection on reproductive performance of cows

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Abstract

Uterine infections in post-partum phase are the *most common and of greatest economic importance in dairy animals. Uterine function is often compromised in cattle by bacterial contamination of the uterine lumen after parturition; pathogenic bacteria frequently persist, causing uterine disease, a key cause of infertility. Presence of uterine bacterial infection, bacterial products delay uterine involution, suppress pituitary LH secretion and perturbs post-partum ovarian follicular growth and function, which disrupts ovulation in cattle. Thus, uterine disease is associated with lower conception rates, increased intervals from calving to first service or conception, and more cattle culled for failure to conceive.*

Keywords: Uterine infections; post-partum period; cattle; reproductive performance

INTRODUCTION

Post-partum reproductive health in dairy cattle is judged by complete uterine involution (return to its normal size and position), free from infection and for cows to have cyclic activities by the time they enter the breeding period (Gautam *et al.,* 2009). 80 to 100% of cows will have bacterial contamination within the uterus after parturition. Post-partum uterine infections can delay the regeneration of endometrium and disrupt the resumption of cyclic ovarian function which leads to the postponement of first insemination (AI), increase in number of inseminations per conception and thus calving interval is prolonged (Foldi *et al.,* 2006). LeBlanc *et al.* (2002) reported that conception rate was 20% lower in cows with endometritis, and calving to conception interval increases by 30 days and about 35% more animals were culled for failure to conceive. Milk production is reduced due to the reproductive tract infection. Also, treatment affects the individual due to high expenses and can reduce the amount of saleable milk due to milk-withdrawal periods. Culling rates also increase when the cow fails to conceive (Sheldon *et al.,* 2009).

Post-partum uterine infection

Bacterial contamination of uterine lumen after parturition often hinders the uterine function (Sheldon and Dobson, 2004). Bacteria can be cultured from samples collected from uterine lumen of dairy cattle in the first 2 weeks after parturition without appearance of any apparent clinical signs and found that intensively managed dairy cattle often have bacterial uterine contamination rates of 90 to 100% within the first two weeks post-partum (Sheldon *et al.,* 2002). Prevalence of clinical and sub-clinical endometrits after parturition ranges between 5 to >30% and 11 to >70%, respectively (Galvao *et al.,* 2009). Uterine infections can be classified as puerperal metritis, clinical endometritis, sub-clinical endometritis and pyometra (Sheldon *et al.,* 2008).

Puerperal metritis

Puerperal metritis usually occurs within Day 10 post-partum and is defined as an acute systemic illness caused by an infection of the uterus (Sheldon *et al.,* 2006). Important characteristic of puerperal metritis is rectal temperature greater than 39.5°C within 21 days after calving. Retained placenta, fetal maceration or difficult calvings are predisposing factors for occurrence of puerperal metritis (Foldi *et al.,* 2006). Up to 40% animals develop metritis within the first fourteen days of calving (Sheldon and Dobson, 2004).

Endometritis

In post-partum cows, endometritis continues to be a major cause of poor fertility and delayed conceptions (Couto *et al.,* 2013).

Clinical endometritis is defined as inflammation of mucus membrane of uterus and presence of mucopurulent to purulent discharge in uterus after three weeks of parturition or later (Turk *et al.,* 2011). Cows with endometritis have deeper uterine tissue involvement, higher degrees of bacterial contamination Clinical findings by rectal palpation of the uterus are asymmetric uterine horns, thickened uterine wall and palpable presence of fluid during clinical endometritis (Foldi *et al.,* 2006).

Sub-clinical endometritis is characterized by scanty exudates accumulated in uterus resulting in complete lack of cervical discharge with pathognomic property and can be diagnosed by endometrial cytology if purulent discharge is absent in the vagina (Gilbert *et al.,* 2005). Sub-clinical endometritis can be defined by greater than 18% neutrophils in uterine cytology samples at 20-33 days or greater than 10% neutrophils at 34-47 days post-partum (Sheldon *et al.,* 2006).

Pyometra

Pyometra is characterized by the presence of corpus luteum on ovary and accumulation of fluid of mixed echodensity in the uterine lumen and distention of the uterus on ultransonographic examination (Manns *et al.,* 1985). There is functional closure of the cervix but the lumen is not always completely closed and some pus may discharge through the cervix into the vaginal lumen (Sheldon *et al.,* 2006). Prolongation of the luteal phase may be attributed to increased concentrations of luteotrophic prostaglandin PGE2 associated with endometrial bacterial infection. Pyometra can occur if ovulation occurs too early in the post-partum period and corpus luteum is formed during uterine infection (Sheldon *et al.,* 2008).

Effect of post-partum uterine infections

Post-partum reproductive health in dairy cattle is judged by complete uterine involution (return to its normal size and position), free from infection and for cows to have cyclic activities by the time they enter the breeding period (LeBlanc 2002; Gautam *et al.* 2009).

Eighty to 100 per cent of cows will have bacterial contamination within the uterus after parturition. Most cows may be able to combat this contamination but due to a period of immunosuppression, around 20 per cent of these contaminations result in infection. Cows with abnormal vaginal discharge are more likely to have an increased anovulatory period or extended post-partum luteal phases. Cows diagnosed with endometritis have 20 per cent lower conception rates and the average interval from calving to conception is 30 days longer. Decrease in reproductive performance is seen even after cows are successfully treated for endometritis. Subclinical endometritis can persist after outward signs resolve which result in an increase in number of days open and more services per conception (Sheldon *et al.* 2009).

Table 1: Effect of uterine infection on post-partum events

Uterine involution (days)		
Normal	**Abnormal**	**Author and Year**
29.4±0.3	37.6±0.5	Zain *et al.* (1995)
35.8	46.3	Usmani *et al.* (2001)
23.0±5.3	33.0±5.3	Hajurka *et al.* (2005)
27.7±6.5	35.6±6.4	Hajurka and Zemlijic (2006)
Post-partum estrus (days)		
22.4±1.4	30.8±3.1	Zain *et al.* (1995)
47.7±20.6	73.0±19.0	Usmani *et al.* (2001)
Number of services/conception		
1.5±1.0	1.7±0.7	Usmani *et al.* (2001)
1.6±0.2	2.2±0.3	Sheldon and Dobson (2004)
2.81±1.1	2.93±1.74	Zainalabdein and Elfagir (2015)
Calving interval (days)		
394±45.87	397.56±47.67	Zainalabdein and Elfagir (2015)
Overall conception rate (%)		
63.0	57.0	Usmani *et al.* (2001)
First service conception rate (%)		
37.9	29.0	Sheldon *et al.* (2008)

Post-partum uterine infections can delay the regeneration of endometrium and disrupts the resumption of cyclic ovarian function which leads to the postponement of first insemination (AI), increase in number of inseminations per conception and thus calving interval is prolonged (Foldi *et al.* 2006). Cows with uterine infections like endometritis have lower first service conception rates compared to healthy cows (29.0 vs. 37.9%). Median days open were longer (151 vs. 119 days) and more animals were culled for failure to conceive (6.7 vs. 3.0%) than unaffected animals (Sheldon *et al.* 2008).

Reduced fertility due to post-partum infection can increase the amount of hormones used for synchronization as well as multiple doses of semen due to increased services per conception. Milk production is reduced due to the reproductive tract infection. Also, treatment affects the individual due to high expenses and can reduce the amount of saleable milk due to milk-withdrawal periods. Culling rates also increase when the cow fails to conceive (Sheldon *et al.* 2009).

Post-partum uterine infections cause important losses to dairy farmers. Metritis, clinical endometritis and subclinical endometritis affect a large proportion of cows, have detrimental impacts on milk production and reproductive performance. So, timely diagnosis is necessary to prevent losses in reproductive performance after parturition. Treatment based on the diagnosis should be done to treat uterine infections. In broad, calving management, pre-partum and post-partum nutritional management, general hygiene and prompt diagnosis through clinical examination and early antibiotic and hormonal treatment is necessary in order to avoid the prolonged effect of cow post-partum uterine infection. As uterine infections affect the cyclicity of animal, intrauterine transport of sperm and embryo implantation thus leading to delayed calving to first service interval and reduced conception rates posing huge economic losses to the farmers, therefore, proper nutrition during pregnancy, hygienic conditions during calving and immediate veterinary care in case of dystocia is required to limit the post-partum uterine infections.

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Organic sugarcane cultivation for livelihood and nutritional security

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Organic agriculture is a system of farm design and management to create an eco system, which can achieve sustainable productivity without the use of artificial external inputs such as chemicals, fertilizers (chemical fertilizers), genetically modified organisms, antibiotics and growth hormones, and pesticides. The organic standards generally prohibit sewage sludge, synthetic drugs, synthetic food processing aids and ingredients, and ionizing radiation. The importance of organic farming is steadily growing in India and has good market price outside India. The findings of several studies indicate that excessive use of chemical fertilizers and pesticides for pest and disease control results in degradation of soil, water and environmental resources and resistance development in insect pest and pathogens. On the other hand, the organic farming had beneficial effects on human health, sustainability of soil, water, and environmental resources and crop yields in the long run.

SALIENT FEATURES

- It will help in production of healthy, nutritious and quality food.
- It will encourage and enhance biological cycles involving soil flora and fauna, plants and animals.
- It will maintain and enhance long-term fertility of soil.
- It will help in soil and water conservation.
- It will maintain genetic diversity.
- It will minimize all forms of pollution that may result from agricultural practices.
- It will utilize on farm resources as far as possible.
- It will help preserve and enhance traditional and indigenous knowledge in farming, seeds and varieties.

Sugarcane is the second most important industrial crop in the country occupying about 5 million hectares area. India is the second largest producer of sugar after Brazil. Largest sugarcane producing state of India is Uttar Pradesh and the second and third largest cane producing states are Maharashtra and Karnataka respectively. Other main sugarcane producing states of India includes Bihar, Assam, Haryana, Gujarat, Andhra Pradesh and Tamil Nadu. The various by-products of sugar industry also contribute to the economic growth by promoting a number of subsidiary industries.

SCOPE OF ORGANIC SUGARCANE CULTIVATION IN INDIA

Sugar industry is the largest major industry next to the textile. Over 5 million farmers are involved in the cultivation of sugarcane. it plays a very important role in nutritional and livelihood security of the people in rural as well as in urban India. Sugarcane is emerging as a multi-product crop is used as a basic raw material for the production of sugar, ethanol, electricity, paper and high value bio molecules, besides a host of ancillary products. Sugarcane contributes about 90 per cent of the sweeteners' production. The sweeteners made out of sugarcane are white sugar, jaggery and khandasari. The sugar used by the majority of the people for daily consumption is processed white sugar. One important step in the processing of sugar cane for the white sugar production is the clarification of the juice obtained after milling. It requires chemicals like sulphuredioxide, lime, phosphoric-acid, formic-acid and bleaching agents for clarification process. On the other hand the production of white sugar through industrial process without involving chemicals will be time consuming and the recovery of sugar will be low because of extended time for settling of suspended solids, frequent overflows of juice and sucrose conversion. Given the various difficulties associated with white sugar production, the organically produced sugarcane can be successfully used for production of jaggery and khandsari, sugarcane juice and also chewing purpose without any loss in return and without endangering the human and environmental health.

In India of the total sugarcane produced, 53 % is processed to whitesugar, 36% in to Jaggery and Khadasari, 3% for chewing as cane juice and 8% as seed cane. It has been reported that About 32 per cent demand of total sweeteners consumption in the country is met out with jaggery and khandsari, mostly in the rural areas and it involves organically permitted chemicals and it can be prepared at the farmer's field. It does not require any sophisticated machineries for its production. Similarly the organic jaggery, khandasari and sugarcane juice has more minerals and other nutrients than white sugar. Therefore, the organic sugarcane cultivation has much role to play in nutritional, livelihood and economic security of people living rural areas. This is a dominant cottage industry in rural India, engaging over 2.5 million people. It will give employment opportunities to the people in rural areas. The organically produced sugarcane products and value added products like sweets made out of organic jaggery will fetch good price in local as well as international markets. According APEDA Report, India exported 2, 92,212.03 MT of jaggery and confectionery products to the world for the worth of Rs. 1,289.26 crores during the year 2015-16. Similarly the organically produced sugarcane will be most preferred by the people especially during festive season like *Pongal* in Tamil nadu.

Jaggery (Gur)/ Khandsari

Gur and khandsari are used mostly in villages and by rural folk. Both are not only important sweeteners, but also important sources of nutrition as they provide vitamins, iron, calcium and carbohydrates. Jaggery, is also known as Gul, Gud, Jaggery, Vellum and Bella in different states in India, is a traditional Indian sweetener, which are produced in addition to sugar from sugarcane.. This is a traditional sweeteners are the natural mixture of sugar and molasses. If pure clarified sugarcane juice is boiled, what is left [usually possessing sucrose (65-85%)] as solid is jaggery. Jaggery is unrefined natural sugar that is produced without adding any chemicals. Jaggery is popularly known as the "medicinal sugar" and is nutritionally comparable with honey. It has been used as a sweetener in Ayurvedic medicine. The jaggery produced in rural industrial sector with good nutritional and medicinal properties can be produced organically. Moulded organic jaggery gets a good price especially during the festival season and also creates employment opportunities for the several persons who produce it and will improve the rural livelihood. As the major producer of Jaggery, the country has recognized as one of the leading traders and exporters of Jaggery to the world. Out of total world production, more than 70% is produced in India. The leading manufacturing states of jaggery goods in India are: Maharashtra, Uttar Pradesh, Bihar and Tamil Nadu. As jaggery products are famous and made in almost all parts of India, it has a rich market. Kholapur jaggery, Marayur jaggery, Central Travancore jaggery are the famous branded jaggery available in India. Khandsari sugar is a finely granulated, crystallized sugar that contains 94-98 % sucrose. Jaggery is unrefined sugar and khandsari is non-centrifuged sugar.

Table 1: Nutritional composition of jaggery 100g

Minerals (mg)		**Vitamins (mg)**	
Calcium	40-100	A	3.8
Magnesium	70-90	B1	0.01
Potassium	1056	B2	0.06
Phosphorous	20-90	B5	0.01
Sodium	19-30	B6	0.01
Iron	10-13	C	7.0
Manganese	0.2-0.5	D2	6.5
Zinc	0.2-0.4	E	111.3
Copper	0.1-0.9	PP	7
Chloride	5.3		
		Protein	280 mg
Carbohydrates(in g)		Water	1.5-7g
Sucrose	72-78		
Fructose	1.5-7		
Glucose	1.5-7		

SUGARCANE JUICE

Sugarcane juice is a delicious and cheap natural beverage. Fresh sugarcane juice is a popular drink in both urban and rural areas of India. This drink is also preferred in various countries growing sugarcane like South East Asia, Egypt and Latin America. It is available at most small street stalls. Sugarcane juice is quite nutritious as it contains natural sugars, 18-20% solids and minerals like iron, magnesium, phosphorous, calcium and some organic acids, protein, starch, gums, waxes, non-sugar phosphatides, thus imparts health benefits to the consumers. Hygienically produced and packaged sugar cane juice has good marketing potential. The sugarcane juice preserved and packed in aseptic packing and bottle has a good storage life and is available during off-season also. Sugarcane juice is a high-energy drink that is natural, sweet and is a healthy alternative to refined sugar added drinks.

CHEWING CANE

Chewing canes are generally softer and contain soft fibers. After the fibers are chewed, they can be easily spit out the pulp once the sugary juice has been consumed. Chewing sugarcane is good for dental health and also highly nutritious. It is considered that chewing cane brightens the teeth and strengthens gums. Chewing canes are commonly sold as street food in markets all over the India.

ORGANIC SUGARCANE PRODUCTION TECHNOLOGIES

Sugarcane grows well on medium heavy soils, but can also be raised on lighter soils and heavy clays, provided there is adequate irrigation. The soils should be well drained. In India it is grown in two distinct agro-climatic regions – the Tropical (largely comprising Maharashtra, Karnataka, Gujarat and Tamil Nadu) and the Sub-tropical (Uttar Pradesh, Punjab, Haryana and Bihar). As far as organic sugarcane production is concerned, the aspects requiring more attention are: fertilizer use and pest and disease control.

PLANTING MATERIALS FOR ORGANIC SUGARCANE CULTIVATION

i. All plant material shall be certified organic. Species and varieties cultivated shall be adapted to the soil and climatic conditions and be resistant to pests and diseases. In the choice of varieties, genetic diversity shall be taken into consideration.
ii. When organic plant materials are available, they shall be used.
iii. When certified organic seed and plant materials are not available, chemically untreated conventional seed and plant material shall be used.
iv. The use of genetically engineered seeds, transgenic plants or plant material is prohibited.

The varieties which are resistant to major insect pests and diseases with good quality and yield characters can be grown. However, the varieties which are found to be more suitable for jaggery, khandasari, juice and chewing purposes should be used for organic cultivation to get maximum return. Co 6304, Co 671, Co 771, Co 772, Co 997Co 7704, Co 8021, Co 92061, Co 90063, Co 86062 varieties are found more suitable for organic jaggery production. The sugarcanes Co 89003, poovan karumbu, Badilla, Waxy Red, Pio 90-196, Pio 90-99, Pio 90-224 and Pio 88-76 are suitable for chewing. CoP 92226, CoC 671, Co 62175, Co 86249, Co 7717, Co 86032 and Co 94012 can be cultivated for juice making.

Planting material should be collected from the organically grown pest and disease free sugarcane crop of 6-8 months old. Two budded setts are better than three-budded setts.75000 two-budded setts/ha are recommended. Sets are treated with Aerated steam or hot water to control primary infection of grassy shoot disease and smut. Setts can also be treated with 0.25% solution of copper based fungicide (Copper oxychlorie or copper hydroxide) for the control of fungus diseases like red rot.

NUTRIENT MANAGEMENT

Cane produced according to organic specifications should not in theory yield less than under conventional production methods as long as the amount of nutrients supplied is the same in the two cases. Study on comparing the use of organic with that of inorganic fertilizers have shown that similar yields were obtained. Well decomposed farmyard manure, poulty manure, goat manure and vermicompost can be used as source of nitrogen. By product of sugarcane factories like filter cake (which is rich in phosphorus) and vinasse (loaded with potassium, organic matter and other nutrients) which can be used in place of traditional fertilizers. Rock phosphate and wood ash which are the rich source of phosphate and potash nutrients respectively, can be applied. Green manure crops like daincha or sunhemp can be planted on one side of the ridges on 3rd or 4th day after planting sugarcane and can be incorporated *insitu* around 45 days after planting. Many findings confirmed that there is an indication of saving of N up to 25% when green manures were raised as intercrop in sugarcane. Inoculation of nitrogen fixing bio-agents like *Azospirillum*, *Azotobacter* and *Acetobacter* brings about 20- 25% economics in the fertilizer nitrogen of sugarcane besides improving the residual nitrogen content of soil. Similarly, phosphorus solubilising microorganisms viz., *Bacillus megstherium, B.poIymyxa*, *Pseudomonas striata, Aspergillus awamori* etc. bring about improvement in P use efficiency. Recently, another endophytic nitrogen fixing bacterium, *Gluconacetobacter diazotrophicus* isolated from sugarcane can able to fix more nitrogen than *Azospirillum* and it can also colonize the roots and able to solubilize the phosphate, iron and Zn.

INTEGRATED PEST AND DISEASE MANAGEMENT

Organic farming systems shall be carried out in a way which ensures that losses from pests, diseases and weeds are minimized. Emphasis is placed on the use of a balanced fertilizing programme, use of crops and varieties well-adapted to the environment, fertile soils of high biological activity, adapted rotations, intercropping, green manures, *etc*. Growth and development shall take place in a natural manner. As the crop is not severely attacked by many major pest and diseases, it does not require many synthetic chemical pesticides. However in case of the areas where pest and diseases are common the following practices can be followed.

- Use only resistant varieties suitable to the area and climate.
- Trash mulching, frequent irrigations and light earthing up at 35th days will result in lower incidence of early shoot borer. Release 125 fertilized female Sturmiopsis parasite/ ha when the crops is at the age of 45 to 60 days for the management of early shoot borer.
- Use cards of *Trichogramma chilonis* in the field @ 25 cards/ha equally distributed in 25 places once in 15 days when the crop is 4-11 months of old.

Alternatively, set up pheromone traps in the field @ 25/ha spaced at 20 meters apart when the crop is 5 months old, trap and kill the male moths of internode borer. Replace the pheromone vials in the traps in 7th and 9th months.

- In places prone to red rot disease grow only resistant varieties such as Co 8021, Co 85019, Co 86010, Co 86032, Co 86249, Co 93009 and Co 94008.
- Use pest or disease free planting materials.
- Prevent the flow of irrigation/rainwater from the red rot affected field to healthy field
- Follow crop rotation for 3-4 years with non host crops like rice.
- Remove and destroy affected clumps
- Do not raise ratoon crop from the disease affected crop.
- Treat the setts with hot water or Aerated steam therapy for the management of smut(50°C for 30 min), RSD(50° C for 3 h) and grassy shoot(50° C for 1 h) *etc.,*

OTHER MANAGEMENT PRACTICES FOR THE SUCCESSFUL CULTIVATION OF ORGANIC SUGARCANE

- Application of cow dung solution for fertilizer and pest management.
- Avoid use of saline/ alkaline water for irrigation as it affect the taste of the juice and quality of jaggery
- Amirtha karaisal, a fermented mixture of cow dung, cows urine and jaggery solution can be used as a liquid manure to increase the soil microbial population and boost to the availability of macro and micro nutrients.

ORGANIC VS INORGANIC SUGARCANE CULTIVATION

According to the study based on primary data collected from two districts covering 142 farmers, 72 growing Organic Sugarcane (OS) and 70 growing Inorganic Sugarcane (IS) in Maharashtra., the yield from organic sugarcane is 6.79% lower than the conventional crop. But it can be compensated by premium price and yield stability observed organic agriculture. In that it was also found that the organic sugarcane cultivation enhanced employment opportunities by 16.90% and its cost of cultivation was lower by 14.24% than inorganic farm besides giving 15.63% higher profits. The profits are more stable in organic farms than inorganic farms.

CONCLUSION

Organic agriculture is gaining its importance in recent times considering its impact on environment and human health. Sugarcane is one of the important crop has very good scope both in local and international markets. The products and value added products of organic sugarcane will fetch good price and improve the financial status of sugarcane farmers besides improving the livelihood and nutritional security in rural areas by improving the employment. However, people are not much aware of the value of products of organic sugarcane like jaggery, khandsari *etc*. Therefore, more awareness should be created among the people about the organic sugarcane products and its pharmaceutical and nutraceutical values. Research should be carried out on technologies suitable for organic cultivation. New organic sugarcane varieties showing resistant to pest and diseases should be developed. Research funding should be targeted for organic research on sugarcane. Farmers should be encouraged to grow organic sugarcane by providing subsidies for cultivation and also for setting up of manufacturing units for jaggery and sugarcane juice production. Modern technologies should be introduced for organic preservation technologies and value addition and packaging of sugarcane juice, jaggery and jaggery based products. Training and demonstration should be given to the farmers and manufacturers about the importance of organic agriculture and rules and regulations to be followed in organic farming. Organic pest and disease management techniques should be strengthened.

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Application of reverse genetics by tilling for crop improvement

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Abstract

Conventional breeding is widely implemented to improve crop plants. Alternative methods such as marker-assisted breeding and reverse genetics approaches have also proved to be efficient in developing crop cultivars. In this article, we present detailed description of a non-transgenic and reverse genetics technique called TILLING (Targeting Induced Local Lesion IN Genomes). The method was originally optimized in the model plant Arabidposis thaliana and subsequently applied to crops such as maize, wheat, and rice.

Keywords: TILLING, Crop improvement, Reverse genetics, Mutation

INTRODUCTION

Over the last century, the global population has quadrupled. In 1915, there were 1.8 billion people in the world. Today, according to the most recent estimate by the UN, there are 7.3 billion people — and we may reach 9.7 billion by 2050. Food demand is expected to increase anywhere to 98% by 2050. This will shape agricultural markets in ways we have not seen before. Farmers worldwide will need to increase crop production, either by increasing the amount of agricultural land to grow crops or by enhancing productivity on existing agricultural lands through conventional breeding and modern breeding approaches like revere genetics techniques and marker-assisted breeding methods.

In this century, there has been a dramatic increase in the amount of genome sequence data available for world major food crops, their pests and pathogens. Complete genome sequences have been reported for rice) and sorghum and also for several crop crops. However, the exploitation of these sequence data for crop improvement is limited by the complexity of many of the traits that determine agronomic performance. In this situation, reverse genetics approaches allow progress to be made on the major challenge of linking sequence information to the biological function of genes and on determining their contribution to important characters and traits. Typically, these approaches rely on the disruption of candidate genes by mutagenesis, transposons, and T-DNA tagging or RNA interference (RNAi).

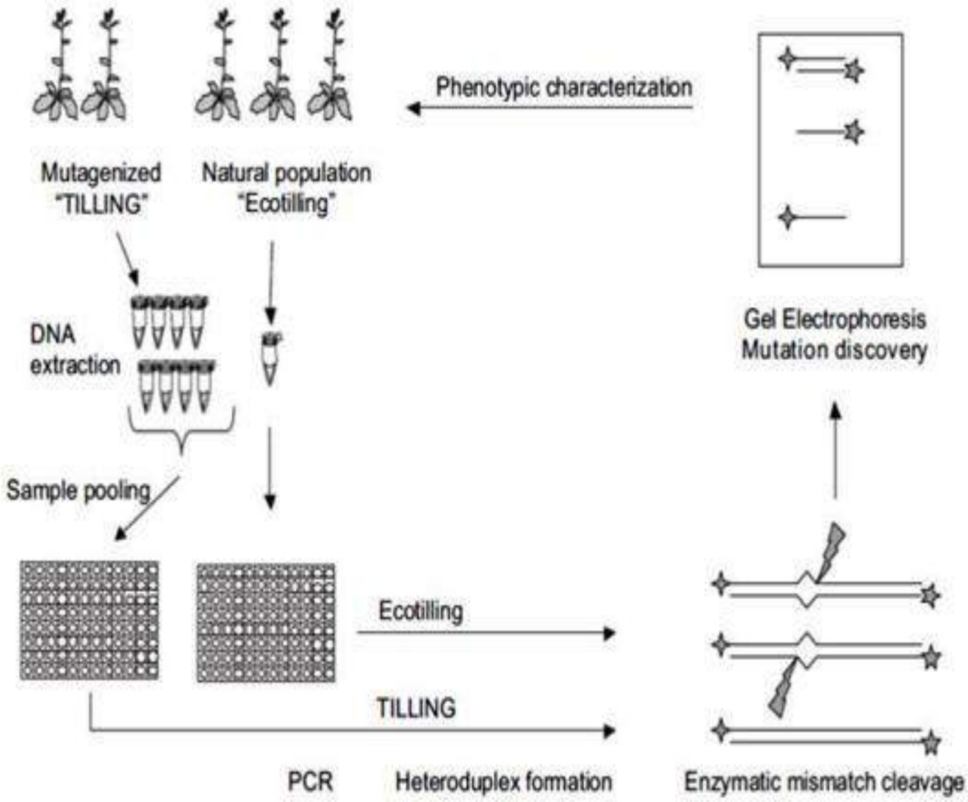
TILLING (**T**argeting **I**nduced **L**ocal **L**esions **IN** **G**enomes) is a non-transgenic reverse genetic technique that is suitable for most plants (McCallum *et al*. 2000a). For TILLING, mutations are created by treatment with the same chemical mutagens that have been successfully employed in mutation breeding programs for decades. Mutations can also be induced by physical and chemical mutagens and are applicable to all plant and animal species. By using chemical mutagens that induce primarily random point mutations at high density, allelic series of missense mutations can be discovered with TILLING. Thus with only a small population, multiple alleles may be obtained regardless of the size of the gene. Gene regions are targeted for mutation discovery using PCR and standard SNP discovery methods. The use of general techniques for the generation and discovery of mutations means that the method should be applicable to a wide variety of organisms.

Mutations may be gross, resulting in large-scale deletions of DNA, or only involve point mutations. Mutation can be induced by irradiation with non-ionizing (e.g. UV) or ionizing radiation (e.g. X and gamma rays, alpha and beta rays, fast and slow neutrons); such physical mutagens often result in the larger scale deletion of DNA and changes in chromosome structure. By contrast, chemical mutagens most often only affect single nucleotide pairs. For plants, some of the more widely used mutagens include ethylmethane sulphonate (EMS), methylmethane sulphonate (MMS), hydrogen fluoride (HF), sodium azide, N-methyl-N nitrosourea (MNU), and hydroxylamine. The degree of mutation is dependent on the tissue and degree of exposure. Mutations at single nucleotide pairs are generally of the most interest to breeders because large-scale changes to chromosome structures usually have severely negative results. However, the use of mutagens that alter chromosome structure to increase the number of recombination events and break undesirable linkages is also extremely valuable. Critically, mutations in important traits or genes (e.g. in nutritional quality, resource use efficiency, architecture or phenology) can be readily exploited by plant breeders without the legislative restrictions, licensing costs, and societal opposition applied to GM approaches. This is despite the fact that transcriptomic analyses have shown that large-scale plant mutagenesis may induce greater changes in gene expression patterns than transgene insertion. This article briefly discusses advances in the detection of mutations and the potential of this approach for crop improvement.

TILLING FOR MUTATIONS

TILLING consists of three main steps: 1) Development of a mutagenized population, 2) DNA preparation and pooling, and 3) mutation discovery.

Development of a mutagenized population



Source: Techniques of TILLING (Bradley *et al*., 2007)

Fig. 1: Outline of the basic steps for typical TILLING and EcoTILLING assays.

DNA is collected from a mutagenized population (TILLING), or a natural population (EcoTILLING). For TILLING, DNAs from up to eight individuals are pooled. Typical EcoTILLING assays do not use sample pooling, but pooling has been used to discover rare natural single-nucleotide changes (Till *et al*., 2006) (Fig 1). After extraction and pooling, samples are typically arrayed into a 96-well format. The target region is amplified by PCR with gene-specific primers that are end-labeled with fluorescent dyes. Following PCR, samples are denatured and annealed to form heteroduplexes that become the substrate for enzymatic mismatch cleavage. Cleaved bands representing mutations or polymorphisms are visualized using denaturing polyacrylamide gel electrophoresis. Plants with mutations predicted to affect protein function can be carefully analyzed for phenotypic abnormalities.

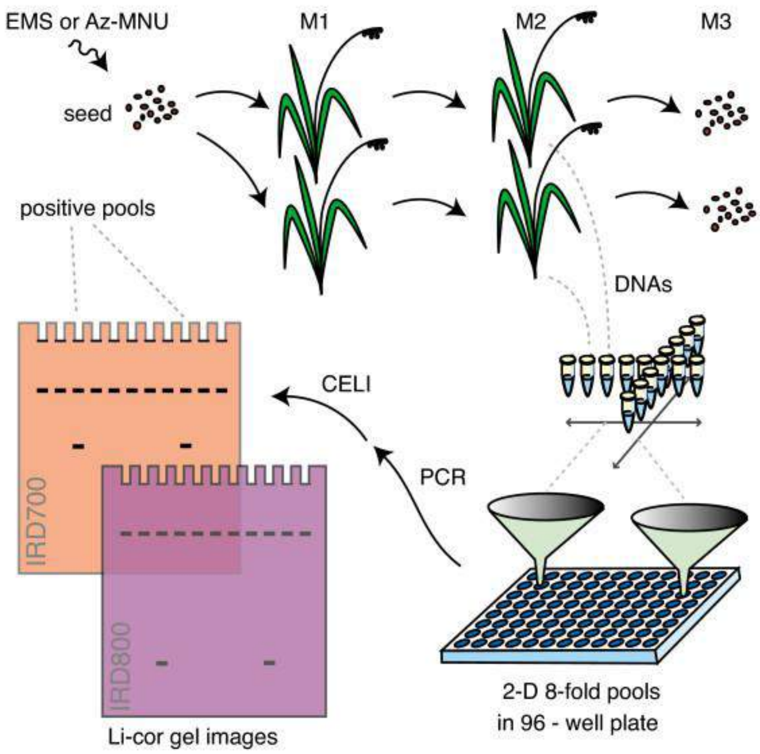


Fig. 2: Seed mutagenesis strategies used for TILLING.

For seed mutagenesis, a single M_2 plant per line is typically included in the TILLING population (Fig 2). The M_1 generation is chimeric for mutations and is unsuitable for TILLING. DNA and seed are collected from the M_2 generation. When mutations are identified, the M_3 seed can be germinated for phenotypic analysis Seed from a self-cross of the M_1 is collected for subsequent phenotypic analysis.

DNA Pooling

In addition to the density of mutations, sample pooling will directly affect the efficiency and cost of mutation discovery. With similar false positive and false negative discovery rates, screening four samples pooled together will take approximately twice as long and cost twice as much as screening a pool of eight samples. Factors that affect the ability to pool include the quality of genomic DNA, the accuracy of sample quantification, and the method used for SNP discovery. Blindly screening samples in various sized pools will allow an unbiased determination of the optimal level of pooling. Various TILLING groups have performed screens utilizing two-, three-, four-, six-, and eight-fold pooling. At the STP, all samples are currently pooled eight-fold.

Two basic pooling strategies have been most often used by the STP. For large scale services, we typically use a one-dimensional pooling strategy where each individual sample is represented in only one pool. When a mutation is identified in a pool of eight individuals, each member of the pool is then screened independently to identify the individual harboring the. The other approach is to pool samples two-dimensionally such that each sample is present in two unique pools. The STP has used a two-dimensional pooling strategy for smaller scale projects and for the larger scale

Maize TILLING service. Although duplicating each sample reduces the throughput of detection in pools by half, the sample harboring the mutation is unambiguously determined in the pool screening step, so that there is no need to screen individual samples as is done in the one dimensional strategy. Also, because two-dimensional pooling involves screening each sample with two-fold coverage, potential false positive and false negative errors are minimized at the initial screening step, rather than when individuals are screened in the second step with one-dimensional pooling. The current approach for STP is to perform small scale pilots using two-dimensional pooling, where error rates are unknown. Before moving to a large-scale operation such as a public TILLING service, the advantage of higher throughput using one-dimensional pooling is weighed against the advantage of one-step determination and a decision is made on a case-by-case basis.

Mutation Discovery

SNP discovery technologies include array-based methods, denaturing HPLC, mass spectroscopy, denaturing gradient capillary electrophoresis and enzymatic mismatch cleavage (Comai *et al.,* 2006). In theory, any accurate SNP discovery method can be used for TILLING. In practice, the method must be both robust and cost effective. The most common method used for TILLING has been enzymatic mismatch cleavage and resolution on polyacrylamide gels to detect the cleaved fragments. It is noteworthy that the choice of enzyme and readout platform can potentially affect the optimal level of sample pooling. Once mutations are discovered, they are sequenced to determine the precise base change. An important advantage of the mismatch cleavage system is that the location of each mutation is determined within a few nucleotides, unlike methods such as denaturing HPLC, which can detect a mismatch but does not identify where it lies in the sequence. By pinpointing the location of the putative mutation, the mismatch cleavage method allows for confident identification of each mutation, whether heterozygous or homozygous, with a single sequencing run, priming with the nearer of the amplifying primers.

TILLING THE PLANT KINGDOM

Arabidopsis *thaliana*

TILLING was first applied to Arabidopsis thaliana (McCallum *et al*. 2000a). A mutagenized population was created by treating seed with EMS, using the single seed descent strategy described in section 2.1. This initial work was done using a denaturing HPLC readout platform and five-fold sample pooling. To facilitate gene modeling and primer design, a computational tool termed CODDLe was developed. CODDLe obtains genomic and protein-coding information from public databases or from the user, constructs gene models, and analyzes them to determine the region that has the highest density of predicted deleterious nucleotide changes. With the success of the basic TILLING system, the goal became to develop a large population and offer TILLING to the Arabidopsis community as a public service. To meet the expected demand, the STP explored alternative SNP discovery methods and decided on the use of the single-strand specific nuclease CEL I and the Li-Cor readout platform. Throughput was increased by lengthening the PCR amplicon size (currently at ~1.5 kb), and by increasing the sample pooling from five- to eight-fold. Throughput was also increased as machine run time per sample was decreased approximately four-fold compared to denaturing HPLC. These improvements allowed the creation of the first public TILLING service known as the Arabidopsis TILLING Project.

3.2. *Lotus japonicas*

Perry and colleagues adapted the TILLING method for the model legume *Lotus japonicus* (Perry *et al.* 2003). Seeds were treated with EMS similar to what was done for Arabidopsis. Samples were pooled three-fold and CEL I was used to digest SNPs followed by readout using the ABI377 denaturing polyacrylamide slab gel system. Their work showed that a different readout platform can be used for mismatch cleavage-based TILLING. They also introduced a phenotypic enrichment strategy to reduce the amount of screening to find mutations of interest. A database was created containing the phenotypes of M_2 plants. For the pilot screen, a target gene was chosen that was known to give non-nodulating phenotypes (SYMRK). A population of 288 plants with nodule and root-specific phenotypes was selected for screening, and 15 mutants were identified with homozygous missense changes plus one mutant with a homozygous splice site acceptor mutation. Some M_2 individuals included in the screen were siblings and a total of 6 novel alleles were identified. While the density of induced mutations is not easily inferred, it is clear that this approach will be more efficient for finding functional alleles than blindly screening the entire population, provided of course that one assumes the correct phenotype.

3.3. *Zea mays*

Samples were screened in four-fold and eight-fold pools using CEL I and the Li-Cor platform. Seventeen EMS-induced mutations were identified in six gene target regions of approximately 1 kb. Maize mutations could be discovered as easily as Arabidopsis mutations by simply increasing the amount of genomic DNA in PCR reactions to maintain the proper ratio of primer to target molecules.

3.4. Wheat

The feasibility of TILLING in a polyploid species was first observed in wheat. Starting with seed mutagenized with EMS, they developed TILLING populations in tetraploid and hexaploid wheat. To target genes, the group designed homeolog-specific primers. Samples were pooled 2-, 4- or 6- fold, mismatches were cleaved using CEL I, and fragments were visualized using a Li-Cor DNA analyzer. Over 200 mutations were discovered in the pilot screen and the estimated mutation densities were exceptionally high: 1 mutation / 40 kb in tetraploid and 1/24 kb in hexaploid wheat. The ~10-fold increase in density compared to other TILLING populations is likely attributable to the protective effects against mutation by increased ploidy. As with maize, the large genome size of polyploid wheat did not have an effect on the ability to TILL it. As with Arabidopsis, >99% of EMS induced mutations were G:C->A:T transitions. Importantly, Slade and colleagues were able to use TILLING to generate a wheat variety with reduced amylose production, which demonstrates the utility of the method for breeding programs, especially those where polyploids are used.

3.5. Other Plant Species

The number of plant species in which TILLING has been successfully applied continues to grow; in barley, rice, soybean, tomato, peanut, and castor worldwide. There are many groups working toward establishing TILLING projects in important crops, and in the near future more successful applications of TILLING will undoubtedly be reported.

CONCLUSION

TILLING is high-throughput and low-cost methods for the discovery of induced mutations and natural polymorphisms. The methods are general and have successfully been applied to many plants, including crops. Now that successes have been reported in a variety of important plant species, the next challenge will be to use the technology to develop improved crop varieties. The utility of induced mutations and natural polymorphism has already been established for crop breeding and so the task is mostly one of implementation.

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