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Growing seed

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MAXIMUM PRODUCTION FROM MINIMUM LAND

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An effort has been made to commercialize agriculture through the introduction of HYV seeds, chemical fertilizers, pesticides, irrigation and mechanization. These components were implemented without considering their side effects into account. Agriculture policy makers have given emphasis on to increase and maximize production, while on the one commercial cultivation increases the yield, it disrupts the environment and quality of life of society on the other. Estimates indicate that Indian population will increase by 130 million by 2020 AD needs production of 325 million tones of food grains. Taking the current food grain productions production scenario into consideration, India has a compulsive need to raise food production by five million tones per year as against 3.1 million tones per year achieved over the past 40 years. This is certainly not a easy task. On the basis of present trend of consumption, estimated requirement for food grain in three years will be around 243.2 million tones and this will further increase afterwards. This is a great challenge before the Indian agriculture. Since the land to man ratio is narrowing rapidly, there is almost no scrope for horizontal expansion to meet the future demand of production.

The unilateral approaches viz., intensive use of agro-chemicals, high yielding varieties, resources, monoculture, etc., followed for increasing the production have generated environmental and biological imbalance which are the major challenges to be met for a sustainable agricultural system. The declining trend in carrying capacity of land and other natural resources have drawn the attention of environmental, agricultural and social scientists in present time to look for an alternative approach for sustaining the resources supporting the ecosystem and human life as a whole. Also, the ever growing population of India triggers the transition from traditional practices to modern biotechnological-based agriculture. In the doorsteps of 21st century, Indian agriculture is facing challenging task to provide food security as well as nutritional security for all.

Agricultural practices have begun to integrate emerging technologies like biotechnology and biofertilizers with traditional practices like organic farming. Biofertilizers ware very useful when used in combination with organic manure and inorganic fertilizers in a balanced proportion. Among biofertilizers, the mycorrhizae (AM), the most common fungal association formed nearly in all cultivated plants whether they are agricultural, horticultural or forestry plant species is gaining importance. Success in promoting sustainable agriculture can be achieved on by many ways. In agricultural research the sustainability may be summarized in their briefest form as maximum plant production with a minimum of soil loss. Within this context of balanced agro system (inputs and outputs), the role mycorrhizal fungi have been found as integral and fundamental link between plant and soil. Sustainable agriculture is the successful management of resources for agriculture to satisfy the changing human needs, while maintaining the quality of environment and conserving the natural resources.

A sustainable system uses its inputs most efficiently and judiciously to maximize the productivity and profitability with least adverse impact on ecological balance. Augmentation of the mycorrhizal fungi along with traditional practices and integration with inorganic fertilizers is one of the important approaches in sustaining plant productivity.

Integrated Nutrient Management (INM): A Potential Component of Sustainable Agriculture

Integrated Nutrient Management (INM) is a broad term encompassing the nutrient cycle among the soil, the crop and livestock, balancing the fertilizer use cum organic recycling, combined use of organic manures and chemical fertilizers, exploiting biological nitrogen fixing and phosphate solubilizing potential, and taking holistic view of crop management system. According to the levels of plant nutrition, even if single nutrient deficiency remains uncorrected, obtaining maximum yield or sustaining present yield level is difficult. INM also includes a suitable variety, use of optimum cultural management, soil and water use for efficient and sustainable crop production.

Fertilizers, farmyard manure, compost residues, green manure, biofertilizers including mycorrhiza are the mian components of INM besides management practices. The major steps in INM are given below:

a. System approach to INM of particular crops and cropping systems in a appropriate manner have been found to be useful and productive because of the integrity of various components influencing the input use efficiency.
b. Based on soil analysis/tests amendments and correction of nutrient deficiencies will result high yield. In phosphorus deficient soils, application of nitrogen will not be much use but combination of nitrogen and phosphorus would be packaged involving mycorrhizalbiofertlizer for sustaining the growth and yield.
c. Agronomic approaches like selection of appropriate varieties, optimum cultural practices, split application of fertilizers at different growth stages, use of coated fertlizers, methods and placement of fertilizers, integration of crop specific biofertilizers, organic and inorganic combinations will provide better returns.
d. Use of green manure is a major practices to be followed in problematic soils to sustain the productivity.
e. Continuous use of farm waste and minimum tillage practices ensures the long-term productivity, stability and sustainability.
f. Adoption of water management techniques including maintenance of farm drains is also a component of INM.

Mycorrhizal Fungi and Its Types

Infact, most of plants growing in normal soil have emycorrhizae, or literally fungus roots,. The fungi grows within the cortex of the roots and send thread-like hyphae out into the soil. These greatly aid the plant roots in taking up the major nutrients phosphorus and trace elements zinc and copper. When we realize that phosphorus is the second most important element after nitrogen for crop growth and that insufficient uptake of trace element can have drastic effects on plant growth, then the importance of these fungi realized on us. The mycorrhiza is a symbiotic association with plant roots which means that both the plant and the fungus benefit from the relationship. Thus fungi extract nutrients from the soil, which they provide to the plant. The plant, in return, supplies the fungus carbon compounds/carbohydrates. Mycorrhizal colonization of the plant roots is quite common in nature; in fact its occurrence is more of a rule than an exception.

There are a number of different mycorrhizal fungi. Some types are visible to the naked eye, as they cover the root surface with a thick mantle of hyphae. These are known as ectomycorrhizal fungi. They associate predominantly with woody plants such as oaks,, birches, spruces and pines. Many form fruiting bodies that we recognize as mushrooms.

Another class of mycorrhizal fungi thoroughly invades the living cells of roots and is referred to as-arbuscularmycorrhizal (AM) fungi after the structures they form inside the roots. They are invisible without the aid of a microscope. These are the most abundant and agriculturally important types of fungi. Researchers are able to observe mycorrhizae by staining plant roots with a simple biological dye. The fungal filaments and spores become coloured and they are thus visible under the microscope.

Application of Mycorrhiza

Mycorrhiza can be applied in various forms. It may be applied either in spores and or colonized root pieces. Some commercial companies produce mycorrhiza and supply in the form of sheared root places blend with perlite or vermiculite as inert materials. Some of the inocula are available in active form (on going symbiosis) where one has to take caution and strictly follow the instructions given on the packet. For transplanted crops, the inculum should be applied in the root zone, not on the soil surface. Mycorrhiza can also applied in a layer below the seeds in mother beds in nursery. The inoculum applied or left on the suface will quickly die, and will be beyond the reach of the growing roots. In case of cereal crops, mycorrhizal inoculum may be applied either through with fertilizer banding implement/equipment, or incorporated as seed encapsulation.

Management of Mycorrhizae in Cropping Systems

In all types of mycorrhiza, fungal hyphae permeate soil and reach beyond the depletion zones developed around the non-mycorrhizal roots. Thus, mycorrhizal roots explore a larger soil volume and have greater absorptive area than non-mycorrhizal roots.

Indian soils are usually deficient in phosphorus, an element that is required more as compared to other major nutrients. Moreover, when applied to soils, phosphorus quickly gets fixed and is immobilized. Hence plants are unable to utilize it. Mycorrhizae help in mobilization/solublization and increase the uptake of phosphorus in plants. Inoculation of plants with mycorrhizal fungi during seeding stage and then transplantation in well-manured fields can certainly substitute the chemical fertilizer inputs, particularly P, to a large extent. This way the production achieved would be sustained without affective the soil productivity and fertility.

Some crop species do-not becaomemycorhizal, and so do not benefit from mycorrhizae. Among these are many species within the cruciferae-the cabbage family. However, most other crop species are mycorrhizal. Thicker rooted crop species are often extremely dependent on mycorrhizae for growth. Although finer rooted crops may not be as dependent on mycorrhizae for growth, they are also mycorrhizal and can function to build and propagate mycorrhizal populations to benefit coarser rooted subsequently grown in rotation, in agriculture, mycorrhizzae form a natural part of cropping systems and of value in phosphorus and zinc nutrition. They are particularly valuable when either phosphorus or zinc is in short supply in the soil because they can extract more nutrients and tip the balance from deficiency to sufficiency.

Mycorrhizal fungal population are not static, particularly in agricultural systems and there are many factors that influence their level in soil. Knowledge of these factor will enable a farmer to get the best value from fertilizer investments, in a phosphorus deficient soil, poor mycorrhizal colonization will produce a crop with nutritional problems, whereas a crop with good mycorrhizae in the same soil will ensure better growth. Mycorrhizae have a key role in determining the effectiveness of applied fertilizer.

Mycorrhizal Research at TERI

A centre for Mycorrhizal Research (recognized at national and international level) has been established at TERI to provides a unique opportunity to researchers and nursery growers to get training and obtain starter cultures for their use. One of the major bottlenecks for large-scale application of mycorrhiza is the unavailability of adequate inoculum, since AM fungus is an obligate sysmbiont and it requires a host of complete its life cycle. At TERI, complete process have been developed by which these fungi can be grown in laboratory (axenic culture or in uitro) conditions. Some of the protocols are in the process of being patented and the technological know-how has been transferred to commercial companies.

Besides the pot culture multiplication, which is the conventional method of inoculums production, multiplication is also being carried out in soil-less conditions where a mist of solution consisting of essential nutrients is provided to trap plants (aeroponics). The on-farm inoculum production of VAM fungi has also been standardized by which the growers the production of transplanted seedlings in mother beds. Apart form this, the mycorrhizal centre is also involved in applied research. Thorough testing and efficacy examinations are done both under green house and nursery conditions and long term field experiments are conducted using appropriate statistical designs.

A large number of nursery and field trails have been conducted by TERI which confirms that the application of mycorrhizal (VAM) fungi increase the growth of plants at reduced fertilizer level. The mycorrhizal inoculation can save upto 25-50 per cent use of phosphatic fertilizers under the use of integrated nutrient management practices.

The centre has also been successful in growing various horticulture and silviculture plant species on abandoned fly ash ponds and arid wastelands and thus has demonstrated using the developed know-how to manage ash ponds in economically viable yet environment-friendly way. The CMR also imparts training in the area of mycorrhizal methods of application and study, information retrieval and modern analytical techniques. (IA)

Conclusions

Maximum Production From Minimum Land includes INM, Mycorrizal Fungi, poultry, fish, tree crops plantation crops, forestry sericulture etc. A combination of one or more enterprises with cropping, when carefully chosen, planned and executed, gives greater dividends than single enterprise especially for small and marginal farmers. Farm as a unit is to be considered and planned for effective integration of the enterprises to be combined with crop production activity.

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RETENTION OF RURAL YOUTH IN AGRICULTURE

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The existing situation of rural youth engaged in the agricultural sector, becoming a threat against the improvement of agricultural sector performance in the future, is the rural young generation's low interest in and motivation to work in the agricultural sector. The data shows that, the maximum number of operational land holders (33.7%), belonged to the age group of 41-50 years, followed by 33.2 per cent in the age group of 51-60 years out of 100 million farmers in India. While this generation is reaching the age of retirement, the next one does not want to farm (Mahapatra,2020).

Many young farmers are taking over high-risk, high returns agri-ventures like protected agriculture, precision farming, organic agriculture, floriculture, medicinal and aromatic plant cultivation, food processing, value addition, agro-tourism, etc., which are mostly avoided by the aging farmers. These new agri-ventures should be actively supported by government agencies and financial institutions with skill training, financing, and marketing support.

Youth participation in agriculture can solve the crisis of unemployment and migration. Questions required to be answered are whether the agriculture sector has enough prospects to provide decent livelihoods to youth, how youth are motivated to take up farming and farm-related businesses, and most importantly, whether leveraging youth for agriculture is an instrument for modernization and future growth of Indian agriculture. (Sukanya Som, *et. al.*, 2018).

Retaining rural youth in agriculture is critical for Indian farming. Most of the innovations (both technical and institutional) required a talented agriculture workforce. Young farmers and producers often have a greater capacity to adopt innovation and entrepreneurship than older farmers. The genuine solution is to take a position of "the rural youth of today, the farmers of tomorrow”. Based on study findings of 21 retention indicators to formulate the “Perspective model of the twenty-one-point programme on retention of rural youth in agriculture” are expected to contribute significantly towards the worldwide and national efforts of skyrocketing production and ensuring food security through increasing rural youth retention in agriculture,

The rural youth (male and female) with the age group of 16-30 years who must have been engaged in agriculture farming was considered respondents in this study.

For the measurement of retention index of rural youth in agriculture, the procedure adopted by (Anamica,2013)was used with necessary modifications. For systematic and accurate measurement of the retention index of rural youth in agriculture.The 21 major indicators with 77 sub-indicators selected on the basis of the result 98 experts or judges of different institutions.

The finishing inventory of indicators was subjected to expert opinions. The experts or judges were from the cadres of Assistant Professor and above in teaching, research and extension faculty of social science group of Dr. PDKV, Akola and other agriculture universities throughout India and scientist working in ICAR Institutions.

The actual facts were collected personally with the help of a structured pre-tested interview schedule and data were analyzed by suitable statistical methods to get a meaningful interpretation and obtained each indicator score used for the groundwork of prescriptive model of the twenty-one-point programme on Retention of Rural Youth in Agriculture (RRYA).

Table 1. Indicator-wise Retention Index Score

Sl. No.	Retention Indicators	Mean Index Score
1	Skill development	76.00
2	Family income	75.80
3	Affiliation	75.60
4	Intrinsic motivation	75.40
5	Autonomy (Self-sufficiency)	75.20
6	Access to market	75.00
7	Quality education	74.40
8	Access to technology	74.40
9	Employment policy	74.40
10	Perception	74.20
11	Access to agricultural input	73.40

12	Aspiration	73.40
13	Health care services	73.00
14	Exposure to agribusiness management	72.60
15	Reward and recognition.	72.60
16	Social support	72.40
17	Access to farm mechanization	71.80
18	Access to finance services	70.40
19	Government schemes	70.20
20	Access to digital technology	69.60
21	Agricultural policy	69.00

Finally, the composite retention index worked out was (73.00). The indicator-wise discussions of the retention Index are presented below.

Prescriptive process model on retention of rural youth in agriculture (Fig.1) based on the field experience and major findings of research outcome.

The prime challenge for the stakeholders is “How to retain rural youth in agriculture”. Keeping in view the outcome of the study, an attempt was made to retain rural youth in agriculture. The prescriptive model is multidisciplinary, focusing on all the possible ways and means for retaining the rural youth in agriculture and providing them handhold support to stay in agriculture

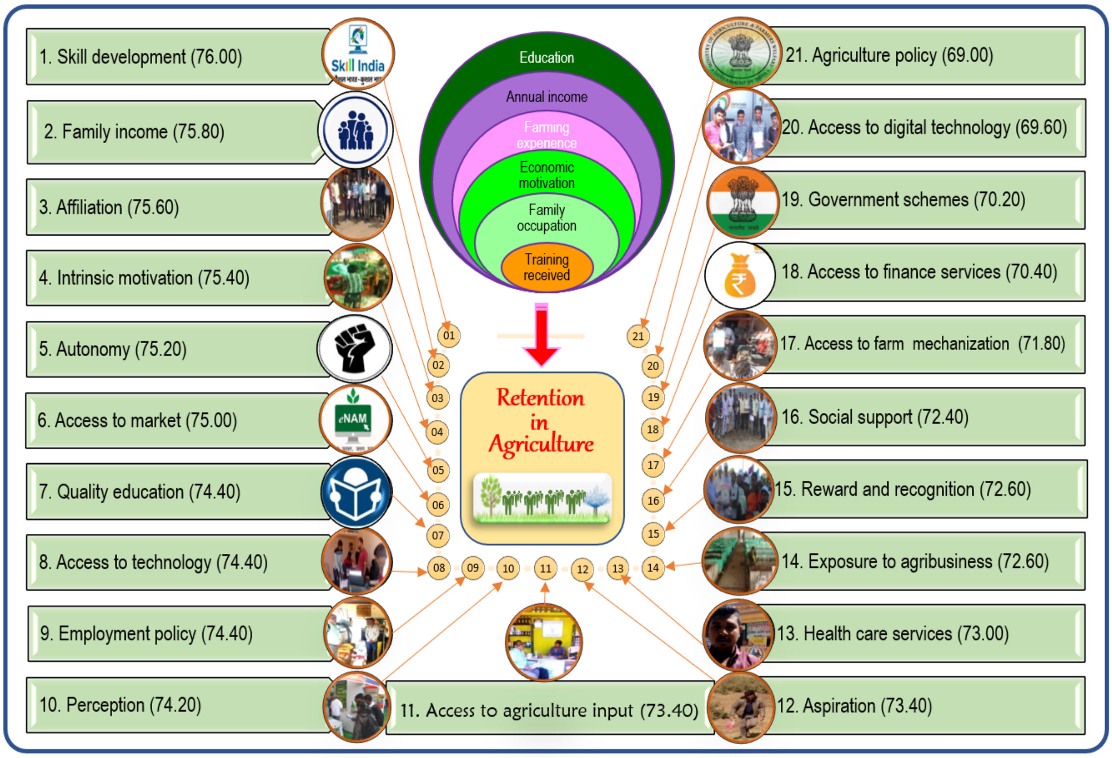

Fig. 1: Prescriptive model of the 21-point programme on retention of rural youth in agriculture

Conclusion

In this study, for measurement of retention of rural youth in agriculture retention index was developed and standardized, on the basis of results of retention index proposed a model on "Twenty-one-point programme on retention of rural youth in agriculture" this model consists of 21 indicators viz., skill development, family income, affiliation, intrinsic motivation, autonomy, access to market, quality education, access to digital technology, employment policy, perception, access to agricultural input, aspiration, health care services, exposure to agribusiness management, reward and recognition, social support, access to farm mechanization, access to financial services, government schemes, access to digital technology and agricultural policy. These indicators are very important in the development of a project or programme. Therefore, it is implied that policymakers, development agencies and extension functionaries should consider these indicators while preparing and planning programs or projects for the development of rural youth.

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CLIMATE CHANGE: IMPACT, MITIGATION AND ADAPTATION

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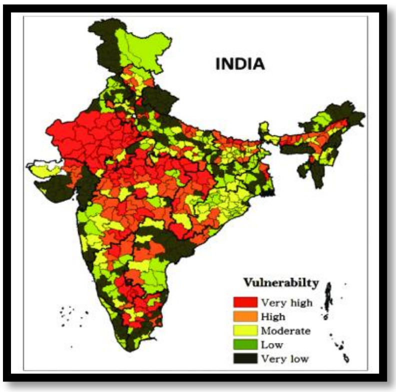
Vegetables are an important component of human diet as they are the only source of nutrients, vitamins and minerals. They are also good remunerative to the farmer as they fetch higher price in the market. Likewise other crops, they are also being hit by the consequences of climate change such as global warming, changes in seasonal and monsoon pattern and biotic and abiotic factors. Under changing climatic situations crop failures, shortage of yields, reduction in quality and increasing pest and disease problems are common and they render the vegetable cultivation unprofitable. As many physiological processes and enzymatic activities are temperature dependent, they are going to be largely effected. Drought and salinity are the two important consequences of increase in temperature worsening vegetable cultivation.

Introduction

For the past some decades, the gaseous composition of earth's atmosphere is undergoing a significant change, largely through increased emissions from energy, industry and agriculture sectors; widespread deforestation as well as fast changes in land use and land management practices.



GHGs trap the outgoing infrared radiations from the earth's surface and thus raise the temperature of the atmosphere. The past 50 years have shown an increasing trend in temperature @ 0.13 °C/decade, while the rise in temperature during the past one and half decades has been much higher.

The Inter-Governmental Panel on Climate Change has projected the temperature increase to be between 1.1°C and 6.4°C by the end of the 21st Century.

Fig 1. Rise In Sea Level

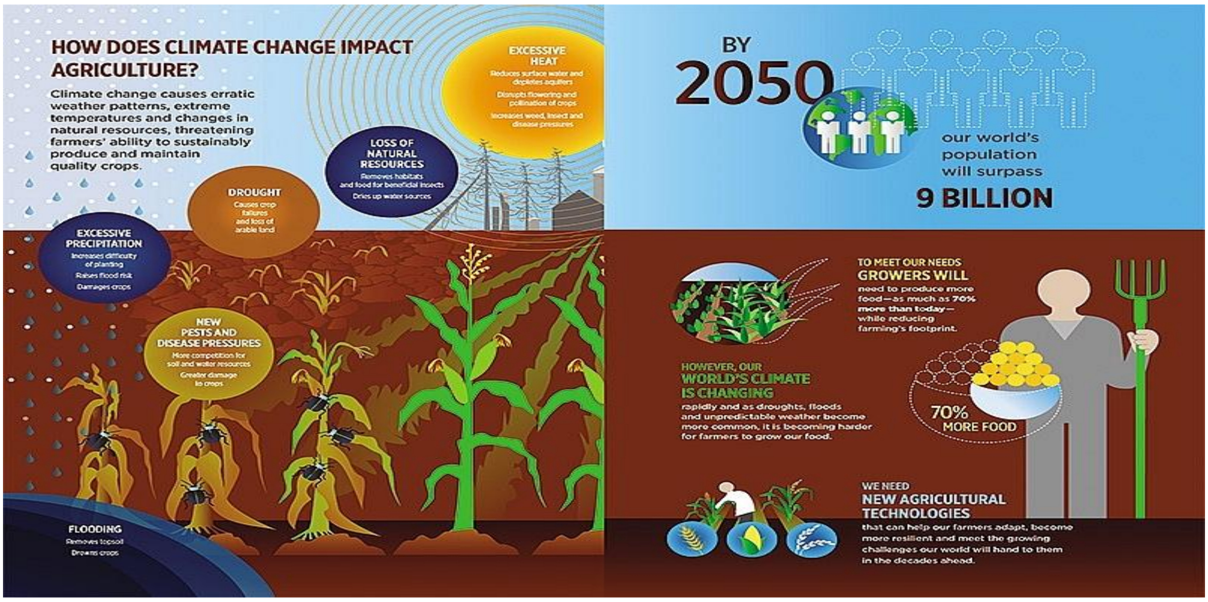
Fig 2. Bushfire in Australia

Concerted efforts are required for mitigation and adaptation to reduce the vulnerability of agriculture to the adverse impacts of climate change and making it more resilient. The adaptive capacity of poor farmers is limited because of subsistence agriculture and low level of formal education. Therefore, simple, economically viable and culturally acceptable adaptation strategies have to be developed and implemented. Furthermore, the transfer of knowledge as well as access to social, economic, institutional, and technical resources need to be provided and integrated within the existing resources of farmers.

Environmental Constraints Limiting Vegetable Productivity

- Climatic changes will influence the severity of environmental stress on the vegetable crops. Moreover, increasing temperatures, reduced irrigation-water availability, flooding, and salinity will be the major limiting factors in sustaining and increasing vegetable productivity. Plants may respond similarly to avoid one or more stresses through morphological or biochemical mechanisms.
- Environmental interactions may cause stress response of plants more complex or influence the degree of impact of climate change.

- Measures to adapt to these climate change-induced stresses are critical for sustainable vegetable production.



Impact on Agriculture

Some of the important environmental stresses which affect vegetable production have been reviewed below.

(A) High Temperature

Heat stress due to increase in temperature is a major agricultural problem in many areas of the world. A constantly high temperature causes an array of morpho-anatomical changes in plant which affect the seed germination, plant growth, flower shedding, pollen viability, gametic fertilization, fruit setting, fruit size, fruit weight, fruit quality etc. Heat stress above 35 ºC has become a major limiting factor for seed germination, seedling and vegetative growth, flowering & fruit setting, and ripening in tomato.



Fig 3. Tip Burn In Lettuce **Fig 4.** Black Heart In Potato **Fig 5.** Buttoning In Cauliflower

High temperatures also interfere with floral bud development due to flower abortion.

VEGETABLES	SYMPTOMS
Asparagus	High fibre in stalks and spears, feathering and lateral branch growth
Beans	High fibre in pods
Carrot	Low carotene content
Cauliflower	Blindness, buttoning, ricyness
Cabbage	Bleached and papery outer leaves
Lettuce	Tip burn, bolting at >30^{o}c
Tomato	Sun burn, sunscaled
Potato	Black heart

Table 1: Physiological Disorders Due To Temperature

(B) Chilling injury in Tomato

The cultivated tomato genotype (*Solanum lycopersicum*, earlier known as *Lycopersicon esculentum* L.) displays limited growth and development at temperatures under 12 ºC. At temperatures between 0 and 12ºC, plants are damaged by the chilling stress. The severity of damage is proportional to the length of time spent in this temperature range.

(C) Drought stress

The water requirements of vegetable crop range from about 6 inches of water per season for radishes to 24 inches for tomatoes and watermelons. Precise irrigation requirements can be predicted based on crop water-use and effective precipitation values. Lack of water influences the crop growth in many ways and the effect depends on the severity, duration, and time of stress in relation to the stage of growth. Nearly all vegetable crops are sensitive to drought during two periods: flowering and two-to-three weeks before harvesting.

Fig 6: Fruit cracking **Fig 7:** Quick bolting **Fig 8:** Blossom end rot

VEGETABLES	SYMPTOMS
Brinjal	Reduced extension of main stem, reduced number of branches per plant
Beans	Few flowers, delayed flowering, low seed protein
Potato	Decreased starch
Cauliflower	Leafy, loose, yellow, small and hard curds
Tomato	Blossom end rot, fruit cracking
Lettuce	Bitter taste, accelerated development of tip burn
Spinach beet	Quick bolting

Table 2: Physiological Disorders Due To Water Stress

(D) Salinity

20% of cultivated lands and 33% of irrigated agricultural lands worldwide are afflicted by high salinity. In addition, the salinized areas are increasing at a rate of 10% annually; low precipitation, high surface evaporation, weathering of native rocks, irrigation with saline water, and poor cultural practices are the major contributors to the increasing soil salinity.

(E) Flooding

Most vegetables are highly sensitive to flooding and genetic variation with respect to this character is limited, particularly in tomato and early cauliflower. In general, the damage to vegetables by flooding is due to reduction of oxygen in the root zone, which inhibits aerobic processes.

- Flooded tomato plants accumulate endogenous ethylene that causes damage to the plants. The rapid development of leaves is a characteristic response of tomatoes to waterlogged conditions and the role of ethylene accumulation has been implicated. The severity of flooding symptoms increases with rising temperatures; rapid wilting and death of tomato plants is usually observed following a short period of flooding at high temperatures.

Mitigation Strategies to Climate Change

To mitigate the possible impact of climatic change on vegetable production as well as on national economy, several initiatives have been undertaken.

These include:

- Selection of better adaptable genotypes,
- Genetic manipulation to overcome extreme climatic stresses,
- Measures to improve water and nutrient-use efficiency and
- Biological nitrogen fixation as well as exploiting the beneficial effects of CO_2 enhancement on crop growth.

Adaptation Strategies to Climate Change In Vegetable Crops

To deal with the impact of climate change, the potential adaptation strategies are:

- Developing cultivars tolerant to heat and salinity stress and resistant to flood and drought
- Modifying crop management practices
- Improving water management,
- Adopting new farm techniques such as resource conserving
- Resource-conserving technologies (rcts)
- Crop diversification
- Improving pest management
- Better weather forecasting and crop insurance

A. Water Management

There are several methods of applying irrigation water and the choice depends on the crop, water supply, soil characteristics and topography. Surface irrigation methods are utilized in more than 80% of the world's irrigated lands, yet its field level application efficiency is often 40-50%. To generate income and alleviate poverty of the small farmers, promotion of affordable, small-scale drip irrigation technologies are essential.

- Drip irrigation minimizes water losses due to run-off and deep percolation and water savings of 50-80% are achieved when compared to most traditional surface irrigation methods. Crop production per unit of water consumed by plant evapo-transpiration is typically increased by 10-50%. Thus, more plants can be irrigated per unit of water by drip irrigation, and with less labour.



Fig. 9: Drip irrigation **Fig. 10:** Protected cultivation **Fig. 11:** Relay cropping

- The water-use efficiency by chilli pepper was significantly higher in drip irrigation compared to furrow irrigation, with higher efficiencies observed with high delivery rate drip irrigation regimes.
- For drought-tolerant crops like watermelon, yield differences between furrow and drip irrigated crops were not significantly different; however, the incidence of *Fusarium*wilt was reduced when a lower drip irrigation rate was used.

B. Cultural Management

- The use of organic and inorganic mulches is common in high-value vegetable production systems. These protective coverings help reduce evaporation, moderate soil temperature, reduce soil runoff and erosion, protect fruits from direct contact with soil and minimize weed growth



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Fig. 12: Red plastic mulch **Fig. 13:** Raised bed & plastic mulch **Fig.14:** Paddy straw mulch

- During the hot rainy season, vegetables such as tomatoes suffer from yield losses caused by heavy rains. Simple, clear plastic rain shelters prevent water logging and rain impact damage on developing fruits, with consequent improvement in tomato yields. Fruit cracking and the number of unmarketable fruits are also reduced.

- Another form of shelter using shade cloth can be used to reduce temperature stress. Planting vegetables in raised beds can ameliorate the effects of flooding during the rainy season

C. Grafting of Vegetables for Stress Management

- Grafting of susceptible plant (scion) on tolerant plant (rootstock) helps to grow plant successfully under stress conditions, especially under salt and drought stress conditions. Grafting of vegetables has been used primarily to control soil-borne diseases affecting the production of vegetables such as tomato, eggplant, and cucurbits.
- It provide tolerance to soil-related environmental stresses such as drought, salinity, low soil temperature and flooding if appropriate tolerant rootstocks are used.
- Melons grafted onto hybrid squash rootstocks were more salt-tolerant than the non-grafted melons.
- Grafted plants are also able to tolerate low soil temperatures. *Solanum lycopersicum*x *S. habrochaites* rootstocks provide tolerance to low soil temperatures (10°C to13°C) for their grafted tomato scions, while eggplants can be grafted on wild brinjal (*S. integrifolium)* as rootstocks to overcome low temperatures (18°C to 21°C).

D. Use of Heat- and Cold-Tolerant Genotypes

- The key to achieving high yields with heat-tolerant cultivars is the broadening of their genetic base through crosses between heat-tolerant tropical lines and disease-resistant temperate or winter varieties.

E. Drought Tolerance

- Most of the vegetables are sensitive to drought; however brinjal, cowpea, amaranth, and tomato can tolerate drought to a certain extent.
- Transfer and utilization of genesfrom these drought-tolerant species will enhance tolerance of tomato cultivars todry conditions, although wide crosses with *S. pennellii*produce fertile progenies.

F. Salt Tolerance

- Screening for salt tolerance in the field is not a recommended practice because of the variable levels of salinity in field soils.Screening should be done in soil-less culture with nutrient solutions of known salt concentrations.
- A few vegetables like, beet palak, tomato, etc. can tolerate salt to some extent.
- Most commercial tomato cultivars are moderately sensitive to increased salinity and only limited variation exists in the cultivated species.
- Genetic variation for salt tolerance during seed germination in tomato has been identified within the cultivated and wild species.
- Wild tomato species, *S. cheesmani*, *S. peruvianum*, *S pennellii*, *S. pimpinellifolium*, and *S. habrochaites*are the potential source of salt tolerance.
- Attempts to transfer quantitative trait loci (QTLs) and elucidate the genetics of salt tolerance have been conducted using populations involving wild species.
- Elucidation of mechanism of salt tolerance at different growth periods and theintrogression of salinity tolerance genes into vegetables would accelerate development of varieties that are able to withstand high or variable levels of salinity compatible with different production environments.

G. Use of Biotechnological Tools in Stress Management

- Use of molecular technologies has revolutionized the process of traditional plant breeding. Combining of new knowledge from genomic research with traditional breeding methods has enhanced our ability to improve crop plants.
- Several QTLs have been identified to stress tolerance in tomato, i.e. for water-use efficiency in *S. pennellii and S. pimpinellifolium*as source of salt tolerance. Only a few major QTLs account for the majority of phenotypic variation, indicating the potential for marker-assisted selection (MAS) for salt tolerance.
- Integration of QTL analysis with gene discovery and modelling of genetic networks will facilitate a comprehensive understanding of stress tolerance, permit the development of useful and effective markers for marker-assisted selection, and identify candidate genes for genetic engineering.

1. **Development of Heat Tolerant Varieties**

CROPS	GENETIC MATERIAL
Tomato	PusaSadabahar, Pusa Hybrid-1, Pusa Hybrid-8, ArkaMeghali, ArkaVikas
Brinjal	KashiSandesh, KashiTaru
Potato	Kufri Surya
Okra	Kasha Pragati, Kasha Kranti
Cauliflower	PusaMeghna
Bottle Gourd	TharSamridhi, PusaSantushti
Cucumber	PusaBarkha
Radish	PusaChetki
Carrot	PusaKesar

Table 3: Heat Tolerance

2. **Development of Drought Stress Tolerant Varieties**

CROPS	GENETIC MATERIALS
Tomato	ArkaMeghali, ArkaVikas
Brinjal	Supreme, Kasha Sandesh
Chilli	Samrudhi, Kasha Anmol
Potato	KufriSindhuri, KufriSheetman
Carrot	Ooty-1

Table 4: Drought Tolerance

3. **Development of Salt Tolerant Varieties**

CROPS	GENETIC MATERIALS
Tomato	Pusa Ruby, Best Of All
Lettuce	Calmar
Okra	PusaSawani
Onion	Punjab Selection
Pea	Market Prize
Cucumber	Pi-177361

Table 5: Salt Tolerance

Conclusion

- A holistic approach is required to over stress tolerance rather than a single method.
- For reducing malnutrition and alleviating poverty in developing countries through improved production and consumption of safe vegetables will involve adaptation of current vegetable systems to the potential impact of climate change.
- Vegetable germplasm with tolerance to drought, high temperatures and other environmental stresses, and ability to maintain yield in marginal soils must be identified

to serve as sources of these traits for both public and private vegetable breeding programmes.

- These germplasms will include both cultivated and wild accessions possessing genetic variation unavailable in current, widely-grown cultivars.

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MICROGREENS: A POTENTIAL ADD-IN FOR HEALTHY DIET

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Micro greens are recently gaining public attention because of their cooking and edible properties. Adding these to raw veggies can enhance the flavor and nutritional values and they can also be used as edible toppings for decorating several food items. The microgreens rose from cabbage, spinach, mustard, lettuce, radish etc. are relished by many. Due to the richness of huge number of biologically active compounds such as antioxidants, vitamins and minerals, the demand of microgreens has been raising high with each passing day. Here in this article the potential health benefits, nutritional values, easy growing procedures etc. have been discussed.

Introduction

The soft tender shoots of a vegetable or herb plant that are consumed at cotyledon stage after appearance of first true leaves are called as microgreens. Mostly they are raised up to a height of 5-10 cm (2-4 inches). Microgreens shouldn't be confused with sprouts, as sprouts have growing period of 2-7 days and are devoid of leaves while microgreens are generally picked up in 10-21 days after germination having emerged first true leaves on them. Thus microgreens are plants that fall in between sprouts and baby greens. They come in wide range of colours, also impart aromatic flavor to variety of dishes and also can be consumed raw as salad. In general, the taste of microgreens varies in a range from neutral to spicy, bit sour or even sometimes bitter. Hence in overall, they give a strong and concentrated flavour.

Different types of Microgreens

Several vegetable as well as cereal and legume crops are now-a-days grown as microgreens to harness their nutritional values at a very early stage. A total of 40 crop varieties are taken into commercial production recently.

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Table 1: Some important food crops for micro-greens

Serial number	Family	Crops grown as microgreens
1.	Amaryllidaceae	Onion, Garlic, Leek
2.	Amaranthaceae	Amaranth, Beetroot, Swiss chard, Quinoa, Spinach
3.	Apiaceae	Carrot, Celery, Dill, Fennel, Coriander, Fenugreek
4	Asteraceae	Chicory, Endive, Lettuce, Radicchio
5.	Brassicaceae	Arugula, Broccoli, Cabbage, Chinese Cabbage, Cauliflower, Radish, Water cress, Mustard, Kale
6.	Cucurbitaceae	Cucumber, Melon, Squash
7.	Poaceae	Barley, Corn, Oats, Rice, Wheat
8.	Leguminoceae	Beans, Chick pea, Lentil, Pea, Mung bean

Cabbage microgreens

Peashoot microgreens

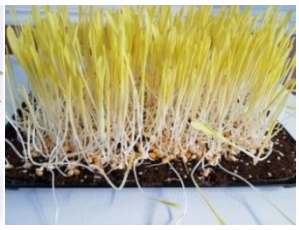
Spinach microgreens

Brocoli microgreens

Mustard microgreens

Radish microgreens

Beet microgreens



Corn microgreens

Nutritional Values

Microgreens are often referred as packet of nutrients. Although their nutrient composition varies a littile, majority of them are reported to be rich source of potassium, iron, zinc, magnesium, copper etc. Apart from these, beneficial plant compounds such as antioxidants are also abundantly present in microgreens. Microgreens mostly contain higher concentration of vitamins, minerals and antioxidants than the amount available in matured greens, thus their nutrient composition is known to be quite concentrated. Several research works has reported that in microgreens, the nutrient content can be comparatively more i.e.

up to 9 times higher than that of the nutrient content found in matured greens (except Amaranthus, where the mature stage contain more amount of nutrients than microgreen stage). Also the matured shoots of microgreens are found to posses several kinds of polyphenols and other antioxidants. A study consisting of 25 commercially grown microgreens showed that the level of vitamins and antioxidants present in microgreens is 40 times higher than those are reported in matured greens, as per the record of USDA National Nutrient Database for mature leaves (Sharma et al., 2020). In comparison with sprouts, also the microgreens are having significantly more amount of nutrient elements.

Health Benefits

Risk of several human health related diseases can be lowered by vegetable consumption owing to the presence of high amount of vitamins, minerals and other beneficial plant bioactive compounds such as carotenoids, phylloquinone, ascorbic acid and tocopherols in them (Mir et al., 2017). Similarly, as mentioned in the nutritional values of microgreens, they contain higher amount of nutrient elements than those of in matured greens, thus contributing in the reduction of risk of different diseases. Some of them are mentioned below:

A. Heart disease: Polyphenols, a class of antioxidants are reported to be packed in microgreens whichis related with lowering the threat of heart ailment. Consuming microgreeens lowers the triglyceride and "bad" LDL cholesterol levels and keeps heart healthy.

B. Alzheimer's disease: It is also called as senile dementia which destroys memories interrupting in brain cell connections and cellular degeneration and finally death. Microgreens are rich source of several antioxidants and polyphenols that can reduce the Alzheimer's disease risk in humans.

C. Diabetes: Antioxidants present in microgreens can assist in bringing down the stress that can restrain sugar from entering into the cells properly. Several studies conducted laboratory suggest that the fenugreek microgreens can apparently augment cellular glucose uptake by 25–44% hence lowering the risk of diabetes**.**

D. Certain cancers: Now-a-days cancer has become one of the biggest threats to human. The cancer cells proliferate in the human body quickly destroying other body tissues. The antioxidant and polyphenol richness of microgreens, can lower the chance of certain kind of cancer risks.

How Microgreens are Consumed?

Several ways shows incorporation of microgreens in our daily diet. Following indicate some of them:-

a. Microgreens can be added to different delicacies that include burgers, sandwiches, wraps and even sometimes can be consumed fresh as salads.
b. They can be used solely for juice extraction or can be blended into smoothies. Wheatgrass juice is now-a-days preferred juiced microgreen.
c. Can be used as a side dish to any main course.
d. Add flavor and colour to an omelet or frittata.

Growing of Microgreens

Growing microgreens is quite easy and convenient, as it doesn't necessarily require much equipments and time. They can be raised both indoors and outdoors round the year. The steps for growing microgreens are mentioned below.

Step 1:- Selecting container for raising microgreens comes first. The containers should be shallow having a depth of 2-4 inches max, as there is no requirement for deep establishment of roots of germinated seedlings. The container must provide sufficient outlets for drainage of excess water.

Step 2:- Next comes growing media. The potting soil should be light in texture and must not be compressed to too thick. Microgreens can be raised on single use growing mats specially designed for growing microgreens. After filling the soil mix in container, it is watered lightly 10-12 hours before planting the seeds of microgreens to settle it down.

Step 3:- Seeds of desired crop are sprinkled over the growing media making sure an even distribution of them. The sown seeds are covered with thin layer of potting soil to secure them. The container is then given a light irrigation and covered with plastic lid or dark cloth to provide a blackout period of 2-3 days. This blackout period helps to induce germination.

Step 4:- Growth of microgreens is monitored regularly and water is given in form of mist to keep the media containing seeds moist. The plastic lid covering is removed, 2-3 days after the seed germination and the growing container is gradually exposed to direct sunlight.

Step 5:- The germinated microgreens are watered depending on the plant requirement and soil condition. When irrigation is given, it should be kept in mind not to wet the leaves of microgreens as it may create congenial condition for various fungal disease incidences, instead they are watered from side of the growing container. Providing water once a day helps the microgreens to grow properly and attain desired colour.

Step 6:-It takes around 7-10 days for the microgreens to be ready for harvest. When they reach a length of 6-8 cm, they are snipped off from the soil by using a sharp knife or a pair of gardening shears. Only the shoot portions are harvested as the microgreen roots are not edible.

Step-7: After harvesting the microgreens are washed properly to remove any soil residue if attached and served fresh.

Conclusion

Adding microgreens to our daily diet can be served as one of the great ways to start a healthy life style. In India, they can be raised quite easily in the kitchen garden or terrace round the year. The size of microgreens might be small, but they are densely packed with several nutrient elements in comparison with matured plants. Consumption of microgreens is tested to be safe for both adults and childrens. Microgreens should be used fresh, as storing them for long can reduce the flavor and cause nutrient loss. Thus they should be eaten within 2 days after harvesting. Taking the potential health benefits into account, microgreens should be incorporated in our food culture.

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ROLE OF CHEMICAL HYBRIDIZING AGENTS (CHAs) IN TWO LINE HYBRID RICE DEVELOPMENT

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Some species are subjected to the temporary induction of male sterility using a variety of compounds known as chemical hybridising agents or by other names (such as male gametocides, male sterilants, pollenocides, androcides). Auxins and antiauxins, halogenated aliphatic acids, gibberellic acid, etheophon, DPX-3718, arsenicals (MSMA, DAA, ZMA, etc.), RH-531, RH-532, and others are examples of this type of chemical. Utilizing these substances causes male sterility in plants, requiring cross-pollination. Different products have varying levels of effectiveness. A chemical hybridising agent (CHA) is a substance that makes male plants artificially and non-genetically sterile so that they can be used as the female parent in the creation of hybrid seeds. Male sterilants, selective male sterilants, pollen suppressants, pollencide, and androcides are some of their other names. These chemicals have an impact on the operation of the male reproductive organs of plants. Because the main goal of the entire process is to produce a hybrid, the term "chemical hybridising agents" (CHA) is used. In order to produce hybrids, a handful of CHAs have been documented to sterilise males. Since maintainer and restorer lines are not required, time, work, and money are saved. Various features of CHA, such as its optimal qualities, mode of action, application to different gametocides in rice, and employment in the creation of two line hybrids, are covered in the present study.

Properties (Features) of an ideal CHA

1. Sterility is induced through a broad-spectrum effect in the sequentially rising panicles.
2. Selective and complete stamen sterilisation that has no impact on ovular fertility
3. Less phytotoxic, noncarcinogenic, and devoid of any lingering toxicity that might endanger people or animals.

4. Not allowed to be mutagenic
5. In the F1 seed, must not have carried over.
6. Must reduces seed set reproduction to a minimum.
7. Must regularly result in total male sterility.
8. Be affordable and simple to implement.

Action Style

The following are the main disruptions that ultimately lead to malfunctioning male gametes:

1. Meiosis disruption causes pollen mother cells (PMC) or curly microspores to degenerate and to stop developing.
2. Exine development is disturbed, resulting in thin-walled, crooked, and non-viable micropores.
3. Starch deposition is reduced, and aberrant vacuoles form inside the micropores, rendering them non-viable.
4. Tapetal layers' persistence and irregular development
5. Anthers that are normally formed but do not dehisce or do so with visible pollen
6. Pollen not germinating on the stigma or the pollen tube no longer extending, preventing fertilization

Various Gametocides Treatment in Rice

Zinc methyl arsenate (CH:AS03 Xn HP) was employed in different concentrations (30, 40, 50, and 60 ppm) by Huang Qun-Ce and Wang Li-Zhu (1990) to induce male sterility in a population of the CIS 28-15 TGMS line that was only partially male sterile. They claimed that by spraying five days before to heading, when the pollen is in its exine stage, full pollen sterility could be achieved in all concentration levels. In India as well as other parts of the world, the successful commercial production of hybrid rice in China has generated substantial interest in research and heterosis breeding. However, the fragility of the CHA line in Indian environmental circumstances rendered it difficult to take advantage of the hybridization effort. Gametocides are capable of working in these circumstances.

Three partially sterile CMS lines, V20 AIR 54753A and IR58053A, as well as a typical fertile variety, BPT 1235, were utilised by Sathyanarayana et al. (1995) to induce total male sterility using three male gametocides, namely ethrel, sodium methyl arsonate (SMA), and natriumarsonate. They claimed that SMA at 500 ppm in the genotype IR 54754A was discovered to be the best therapy among the available options since 100% pollen sterility could be attained with the least amount of phytoxicity. More plant damage was caused by lower plant height and shorter panicles at higher chemical concentrations.

Gangarao *et al.,* (1996) investigated how four chemicals affected rice and found that ethrel was the most successful in causing pollen sterility (94–95%) at 10,000 ppm. At 600 ppm, natrium arsenate was found to produce 49.9% sterility. They claimed that the other chemicals tested—TIBA and streptomycin—were less successful. Further research in this area would be very beneficial to standardising the chemical hybridization technique as an addition to the three line breeding scheme.

Uses of CHA to Develop Two Line Hybrids

Chemically Induced Male Sterility

Chemical hybridising agents (CHAs), which have the ability to produce hybrid rice seeds, have been the subject of attempts since the early 1970s. Ethylene-releasing substances, extremely carcinogenic arsenic substances, and growth hormones are only a few of the chemicals that have been explored thus far. In commercial hybrid seed production, gametocides were likely exclusively utilised in China, but their use has since decreased due to research showing that they are harmful to human health. When rice hybrids created with CHAs were evaluated alongside 3-line bred hybrids, the results showed that the yields were frequently greater and regularly equivalent. Over time, seed yields have increased from 0.4 t ha-1 with 40–60% seed purity to 1.5 t ha-1 with 80–90% seed purity. Total male sterility must be selectively induced by CHAs. The application of CHAs should occur at the stage of stamen and pistil primordia production or stage IV to maximise their impact (i.e., the gametocidal effect varies from variety to variety). Oxanilates were discovered to be successful in India when sprayed on rice plants at stage IV (the meiotic stage), and variety Pusa 150 was sterilised more efficiently by the gametocidal spray than other varieties, demonstrating genotype specificity (Yogendra Sharma and S.N. Sharmal 2005). Any cross between two heterotic parents can be utilised to directly produce hybrid seeds. For instance, in the 8:2 ratio, Y2 and X2 are employed as male and female seed parents, respectively, for the generation of commercial hybrid seeds by chemically treating the seed parent, excluding the female reproductive system and only influencing the male reproductive system. Therefore, any disruption of the tapetal layer (pollen grains) results in male sterility. Even excessive tapetal cell protrusion crushing microspores has been known to result in sterility

(Frankel and Galun, 1977). Since the tapetal cells that surround the forming pollen cells act as a route for nutrition, they are crucial to the development of pollen grains. More plant damage was caused by lower plant height and shorter panicles at higher chemical concentrations.

Benefits of The Two-Line Approach through CHA

- Superior hybrid combinations can be created using a wide variety of types.
- The process of making seeds is less complicated than three-line breeding because it does not call for the creation of three lines (A, B, and R).
- If the non-synchronization of blossoming or persistent rain prevents the CHA from being effective,
- The production of the sprayed unaffected female would still be sufficient during the critical stage, preventing huge crop losses.
- A spray of an appropriate CHA can totally sterilise partial CMS lines and EGMS lines.
- In CHA derived hybrids, the problem with the three-line rice hybrids' limited genetic basis for cytoplasmic genic male sterility is no longer present.

The Drawbacks of CHAs

- The production of impure hybrid seeds in the event that the CHA is unsuccessful due to bad weather or unsynchronized tillering and development.
- Health risks associated with some CHAs (such as zinc methyl arsenate or sodium methyl arsenate).
- The chemicals are very expensive.

The potential value of gametocide as a breeding technique has already been alluded upon. Their ability to create hybrid seeds in kilogramme amounts rather than the typical gramme quantities achieved by conventional hand crossing producers is maybe their greatest benefit in this two line breeding.

Conclusion

Allusions have already been made to the possibility that Gametocide can be important breeding tools. The relative ease with which kilogramme quantities of hybrid seeds can be produced using chemical hybridisingagents techniques, as opposed to the gramme quantities typically obtained by conventional methods, may be their greatest advantage in this context. However, it is clear that, despite their inherent benefits, research on the development of those benefits created a virtual vacuum for gametocidal research during the past. However, in recent years, numerous foreign corporations have tested and created proprietary sterility inducing hybridising agent's proprietary sterility inducing hybridising agent's proprietary sterility inducing hybridising agents to public and seed company breeders. As a result, there is a dearth of published data on the newest compounds. Research an effort needs to be intensified in research stations to develop efficient gametocides and their potentials needs to be realised.

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RECENT ADVANCES IN INTEGRATED MANAGEMENT OF VEGETABLE DISEASES

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Vegetables are a significant source of vitamins, minerals, and other nutrients. Due to their therapeutic and nutritional benefits for human health, vegetables are recognised in both developed and developing nations as a vital part of a balanced diet. Vegetable output is steadily increasing. China presently produces 237 million tonnes of veggies, placing it #1 in the world. Vegetable output in India has increased dramatically, placing it second in the world. More than 91 million tonnes of vegetables are produced nationwide. Despite this, vegetable productivity per unit area is quite poor. As a result, the current crop yields only meet about half of the dietary standard's 250–300 gm/day/adult requirement. Since vegetables are more succulent and nutrient-rich, they are more likely to get diseases, which results in substantial yield losses throughout the pre- and post-production phases. The primary causes of low output in vegetable crops are the high disease pressure from seedling through harvest, which is mostly brought on by fungus, bacteria, and viruses.

Management of Vegetable Diseases-An Over View

According to a review of the literature, vegetables produced either directly or through transplanted seedlings have a range of biotic, mesobiotic, and abiotic problems. Cultural practises, host resistance, chemical control, physical control, and biological control procedures are always advised as control measures. Different approaches have been suggested for managing various diseases, but a lot of them call for the use of pesticides, which raises concerns about economic hardship, insect resistance, and residual toxicity. Application of integrated disease management (IDM) seems to be the best course of action given the current situation's projected increases in output and decreases in pesticides' adverse effects.

Integrated Disease Management (IDM)

A desired approach to the selection, integration, and application of techniques on the basis of their predicted economic, ecological, and social effects is stated in the philosophy, principles, and purpose of IDM. The following parameters must be taken into account when establishing IDM schedules in order to reduce losses caused by disease to vegetables.

- Create a timetable that is cost-effective. Application costs and disease-related crop losses must be appropriately balanced in favour of growers.
- The schedule development was in line with the growers' production protection schedules.
- The established schedules must aim to control the majority of pest and disease problems in the targeted crop concurrently.
- In order to be effective, the IDM timetable for vegetables must be implemented as a community programme and/or cooperative programme.

Management of Vegetable Diseases: The Existing Technology

Prophylactic measures or host resistance may be used as control measures depending on the kind of vegetable diseases. Applying the exclusion, eradication, and protection principles would enable the application of the prophylaxis concept. Quarantine, inspection, certification, and seed treatment have all been suggested as exclusion strategies. It has been advised to utilise biological control, crop rotation, agricultural waste destruction, sanitation, and the removal of collateral and alternate hosts in order to achieve the eradication of inoculum. Those precautionary measures that operate as a barrier between the host and infections (no contact). Cultural procedures such planting techniques, sowing or transplanting times, balanced fertilisers, regulated irrigation, spraying of micronutrients, and the use of pesticides, fungicides, antibiotics, and nematicides, among others, are advised.The best technique for managing illnesses, in general, appears to be the utilisation of resistant genotypes. Introduction, selection, hybridization, mutation, biotechnological, and molecular techniques are employed to generate resistant genotypes. Due to the evaluation of novel biotypes, pathotypes, and races, the development and usage of resistant genotypes is a continual and never-ending process. As a matter of fact, the development of disease resistance in vegetables has not yet taken place, and grains and pulses have received attention in their stead.

Guide lines for Developing IDM

- Vegetables are distinct from cereals in that there is more time to implement management techniques because grains are only harvested once after seeding. However, because most vegetables are harvested several times at various phases of crop development, the application of control methods, particularly fungicide, is hampered by a lack of time and regard for safe periods.
- Vegetables are continually grown using intensive gardening techniques. Because of these activities, primary inoculum is more likely to survive, infect crops, and transmit secondary inoculum. The influence and impact of intensive farming on diseases must be the primary input in establishing any IDM programme to assure success.
- Vegetables are still raised on a limited basis in India. Beans and cucumbers are perennially cultivated close to the home, and because no preventative precaution is always taken, the crops represent a reservoir of disease inoculum. When creating the timetable, the main sources of inoculum must also be taken into account.
- The timetable developed must be simple to use and successful at the cooperative or community level.

Development of IDM Schedule for Diseases of Brinjal-An Example

The illness that affects brinjal is brought on by fungi, bacteria, viruses, phytoplasma, and nematodes. The most significant diseases, however, are Bacterial wilt, Root-knot, Phomopsisblight and fruit rot, Sclerotinia blight and fruit rot, Phomopsis blight and fruit rot, Alternaria leaf spot, and Cercospora leaf spot. The main inoculum of the diseases mentioned above can be found in/on seeds, soil, diseased crop debris, or both as facultative saprophytes. Schedule development must target both first and secondary inoculums since secondary inoculums created after infection spread by air, water, insect, and during cross-cultural interactions.

The Schedule

i. Raised nursery, with a raised solarized bed that preserves soil moisture and plant density.
ii. Refrain from applying a lot of nitrogen and frequent watering.
iii. Use healthy and certified seeds.
iv. Treat seed by physical and chemical means using heat or fungicide. Among fungicide, thiram, captan@ 0.25%, Carbendazim @ 0.1%, Apron @ 0.4%.

v. Destruction of crop debris, deep summer ploughing, organic amendment, crop rotation, date of sowing/transplanting to be used as per recommendation.

vi. While transplanting root treatment either with fungicide or bio-agent.

vii. Application of nematicide /fungicide/ for the control of inoculum existing in soil.

viii. Foliar application of required pesticides.

ix. Use of resistant/to tolerant varieties/ cultivars.

Conclusion

The disease affects plants through both biotic and abiotic ways and results in a considerable loss for the agricultural sector. The development of locally relevant techniques and solutions that are suitable for their particular farming systems and the integration of control elements that are both ecologically sound and easily accessible by them are crucial for the success and sustainability of IDM strategy, especially with resource-poor farmers. The successful implementation of IDM techniques continues to depend on the training and awareness-raising of farmers, disease survey teams, agricultural development officers, extension agents, and policymakers. All direct stakeholders, such as farmers, extension agents, and regional crop protection specialists, have to be conversant with the ecology, aetiology, and epidemiology of the major crop diseases. Farmers should get intensive training utilising participatory methods so they may gain the information they need to manage their own fields more effectively. This knowledge can then be translated into useful decision-making tools and effective control strategies.

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Lotus, *Nelum bonucifera* also known as Indian lotus, sacred lotusis native to Asia and Australia and is an aquatic plant under the family Nelumbonaceae. It requires air temperature at least 21^{o}C and blooms after 3-4 weeks in water above 27^{o}C. It needs 6 hours of direct sunlight to flower. It is one of the sacred flowers that are used for blessing in Hinduism and Buddhism.

Courtesy: AAA セッションー Divine Human Alchemy

Commercial Use of Lotus

The main consumable parts of lotus are rhizome and seed. Rhizome is very popular in Asia as it is consumed as vegetables. In Manipur also, this rhizome is very popular for making a dish called *"Singju" (Vegetable Mixture/Salad).*

Flowers, leaves and seeds are used as medicines. Flowers are used for worshipping in different parts of India. Seeds are also used for eating purpose. It helps in preventing bleeding, cough, fever, liver and stomach-ache. Sometimes, it is used for seasonings and flavours. It is also believed that lotus helps in swelling, cancer cell, heart and blood vessels. It is used for cosmetics and perfumes.

Lotus Silk

It is one of the rarest fabrics in the world. It is produced across Cambodia, Myanmar and more recently produced in Vietnam and India also. Just for extracting lotus silk by a person for one scarf, it usually takes 2 months. The only variety that can produce lotus fibre is *Padon-ma-kya.* It is of two varieties viz. Large and Small *Padon-ma-kya.* The large one contains spike up to only half of the stem while the other contains spike all over the stem. It grows in running water and deep down at 7 feet. There are 3 colours for this variety viz. white, red and pink and only, the pink one is used as the other two (white and red) cannot produce fibre. The nature colour of the lotus fibre is greyish yellow or pale yellow with different colour variations along the thread. The ideal stem of lotus fibre has no flowers and is pink in colour.

It is luxurious as it is done only by hand and also requires high skill to extract and weave it for final products. The products weaved from lotus silk is durable, and adaptable to weather conditions viz, warm during winter and cold during summer and also produce fragrance from the silk. The weight of the products is also too light, soft and water resistant.

Steps of Production for Lotus Silk

Firstly, the leaves from the stems are taken out after harvest. Then, the stems are cleaned and wrapped it with wet clothes to keep it wet. The stem is dipped in water overnight for 2 days. After this, the fibre should be extracted from the stem within 10 days while it is wet or else the stem is break. Stems are cut into halves by blade or knife and stretch at opposite sides. Blade or knife is used as it is not easy to break the stem. We can see the fibre coming out from the stem. Once the threads come out, we need to twist and roll them with the hand on the table. We stretch until all the fibres from the stem are taken out. Then again, from the cut stems just 3 inch from the end, it is again cut with a blade and stretched it again. This procedure is done again and again until the fibres extracted becomes thick. Then, the fibres are rolled together to form a strong thread like structure. During the whole process, water is sprinkled over the fibre to make it wet. After the fibre is extracted, it is put under shade. The threads are washed thoroughly before drying to Sun. Traditional glue made from rice is applied to the thread and after that rubbed with wax. After that the lotus silk is spin in order to put onto the loom with the help of spinning wheel. For dying purposes, natural materials such as tree barks, seeds, jackfruit and lotus leaves are used. Then, the weavers make into final product in the form of scarf, shawls, etc. by weaving with traditional loom.

	
Courtesy: Pinterest Step1: Lotus Harvesting	Coutesy: NguyễnHuệHảiNgoại: LụaTơ Sen Ở Myanmar (nguyenhuehaingoai.blogspot.com) Step 2: Lotus Fibre Extraction
	
Courtesy: Lotus Silk: A Sacred Luxury (onlineclothingstudy.com) Step 3: Preparing Lotus Yarn	Courtesy: Pros of New Kintakun Luxury - Kintakun Collections (kintakun-bedcover.co.id) Step 4: Lotus Fibre weaving
	
Courtesy: Lotus Weaving (annheritageinle.com) Step 5: Weaving Lotus Fibre	Courtesy: Long live the ingenuity of the textile industries| Mid&Plus (midetplus.fr) Step 6: Dyeing Lotus Fibre

Case Study on the Inle Lake of Myanmar

Courtesy: A Complete Guide for Traveling to Inle Lake (halfhalftravel.com)

In Myanmar, about a century ago, a woman, Daw KyarOo, wove a robe from lotus fabric for the first time to give to a Head Abbot at a local Buddhist temple. In Myanmar, lotus has a high symbol of religion and spiritual power. After her death, her relatives review the weaving techniques and take under her footsteps to continue the lotus weaving work.

Inle Lake is located in Nyaungshwe Township of Shan State and is a part of Shan Hills in Myanmar. It is the 2nd largest lake in Myanmar. In dry season, the average water depth is 7feet with deepest point being 12 feet and during rainy season, the depth is increased by 5 feet. Inle Lake measures 22km long and 10km wide and is a home to Intha people. The transportation is done by boats on the lake.

Lotus plants grow abundantly in Inle Lake due to its perfect geographical and its suitability conditions. Unique fabrics from the lotus fibres in this Inle Lake and so many tourists came to this place in order to observe the ancient technique of lotus silk extraction. The threads are extracted from the sacred lotus (*Nelumbium speciosum).* It attracts more buyers due to the increase in tourists since Myanmar opened its doors to vacationers in 1990s. While the tourist came for the visits, the people in the shops of lotus fabrics try to demonstrate how to extract fibres from the stem of the lotus. The fabrics became popular to singers, modellers, actors for its uniqueness and even attract international clothing brands. Due to the increase in demand, the raw materials are even taken from different parts from Myanmar. Japanese and Italian designers are already incorporating the luxury fabrics into collective and finished products sold for thousands of dollars.

A few kilometres from the Lake, a school is located and is run by a master weaver Khin Win Kye. This school mainly focus to train the young girls for fabric extraction from lotus stem. There are no tuition fees for this school and donations are given by non-government organisations to run this school.

Firstly, lotus fibre extraction was done mainly to give offerings to Buddhism abbots in the form of lotus robes, but nowadays it is being used to weave scarves, shawls, clothes, etc. In InleLake, most of the experts that are experts in lotus weaving are old women. Most of the older women turns the threads into yarn and weave while the younger ones mainly focus on the fashioning of the clothes designs. Most of the people working under the shops and workshops are older women and also gives chance to older women in their 70s and 80s to earn their living by lotus plant picking and gathering, weaving, extracting fabrics. The supply chain for the finished products has also grown higher due to increase in demand. Occasionally, silk and lotus threads are also mixed together to make different products but the pure lotus is the one that is more expensive.

The best season to harvest this lotus is from June to November. Nowadays, people have their own plantation of lotus and harvests from it while in the past wild plants are harvested. There is a belief in the past days for this Inle Lake people that the fibre extractor must be an unmarried woman and women in their periods should not extract fibre during the past but nowadays married women even extract fibres from lotus. Middle aged women are mostly doing the extraction process while young girls work together to train themselves for this extraction process. The stems after the extraction of fibres are thrown to the lake in order to give benefit to the lotus plants as fertilizers.

Conclusion

In order to extract the fibre, the stems must be kept wet at all cost even during the extraction process to prevent from breaking. Lotus fibre extraction gives positive economy in Myanmar and gives the chance to earn money for many local women residing at the Inle Lake. The lotus fabric attracts even the international clothing brand due to its uniqueness and durability. The Inle Lake makes a tourist site for lotus fabrics and due to its high demand, some of the raw materials are even taken from elsewhere inside Myanmar. The products that are produced from lotus fibres are luxurious and expensive because of time consuming factors and requirement of high skills from the extractors and weavers. The quality of the fibre or products made from it depends on the skills of the extractor.

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DIVERSITY, DISTRIBUTION AND ECONOMIC IMPORTANCE OF *Bambusa polymorpha*

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Forests provide various support materials and natural capital to the farmers of forest dependent communities. Bamboo, a popular group of grass family Poaceae (Gramineae) belonging to sub-family Bambusoideae. It is estimated that over 1200 species of bamboo are known to occur in natural forests, semi-exploited stands, and intensive plantations. Bamboo grows above the sea level in tropics to 4000 meters in temperate regions. For the sustainable production of materials, bamboo becomes important. Wood of bamboo is gaining more popularity in India for various applications, replacing the utilization of conventional timber of high priced tree species.

The industrial development of bamboo in developing countries is providing new opportunities to younger generations to retain and continue its traditional techniques to harvest, process and ultimately use bamboo. Bamboo industries in Asia have a large market and are quickly spreading across the continents to Africa and America (FAO, 2007). India is the seventh largest country in the world having total geographical area of 328.73 Mha, support over 16.7 percent of the world population.

Description and Morphology

Bambusa polymorpha commonly known as *Burmese* bamboo is a caespitose (small dense clump) bamboo and belongs to the family Poaceae. It is a tall, grayish green colored bamboo species, having large numbers of branches and growing in a closed culm. It prefers a mean annual rainfall in the range 1,100 – 2,500 mm to promote maximum growth, but tolerates upto 900 – 4,300mm. The bamboo grows in light shade, tolerating full sun. Its significant growth can be seen in deep, fertile, well-drained, loam soils with pH in the range 5 - 6, tolerating 4.5 – 6.5.

Table 1: Characteristics of *Bambusa polymorpha*

Height	15-25 cm
Diameter	7-15 cm
Growth habit	Dense clumping
Climate	Tropical-Sub tropical
Hardness	0°C
Origin	Southeast Asia

Table 2: Mechanical properties of *Bambusa polymorpha*

Properties	Strength	
	Green conditions	**Air dry conditions**
Modulus of elasticity	3.2 kN/mm^2	3.9 kN/mm^2
Modulus of rupture	27.3 N/mm^2	35.6 N/mm^2
Fiber stress at elastic limit	13.8 N/mm^2	16.0 N/mm^2

Bamboos are usually monocarpic and living for many years before flowering. Most bamboo species flower infrequently, certainly at an interval of 30– 80 years. The estimated life cycle of *Bambusa polymorpha* is 60 years. Burmese bamboo has gregarious flowering for about 2 - 3 years. After the mass flowering of bamboo of particular species, they die. These flowers are pollinated by wind. The production of 1000 seeds weighs 38 grams. Natural regeneration is done through seed. A bamboo seedling needs more than 10 years to develop into a mature clump. Each culm produces a number of new stems annually and attains their maximum height in their first year of growth. In mature tropical species, the new stem could reach a height of 30 meters, with daily increment of 30cm or more during their peak growth period. This characteristic of *Bambusa polymorpha* makes them one of the fastest-growing species in the world.

Growth originates from a unique rhizome system. Branching occurs from the mid-culm to the top, reaches a height of 15 - 25 m, 7 - 15 cm in diameter, smooth, and covered with white powder. The culms are harvested of culms when the clumps are more than 5 years old. For construction purposes, 2 years culms can be harvested. For the sustainable growth of bamboo, at least 8 - 10 old culms should be left in the clump. The sheaths of growing shoots are golden yellow color, with cup shaped blades. Leaves are used as an excellent cattle fodder.

Distribution

The major bamboo producing countries in Asia are China and India accounting for approximately 70% of bamboo in Asia. *Bambusa polymorpha* is suitable for light (sandy), medium (loamy) and heavy (clay) soils and prefers moist soil. It can be grown in semi-shade (light woodland) or no shade. The culm can tolerate strong winds but not maritime exposure. *Bambusa polymorpha* is a large dense clumping tropical bamboo native to Myanmar, Thailand and widely distributed throughout North-east India, Bhutan and Bangladesh. The areas particularly rich in bamboo are Madhya Pradesh, Northeastern states, Western Ghats and Andaman and Nicobar islands.

Economic Importance

Bamboo is economically important non-timber forest product (NTFP), popularly referred to as "poor man's timber" and a good substitute for expensive wood from trees. It is considered as one of the largest reserves in Indian sub-continent. India is the seventh largest country in the world having total geographical area of 328.73 Mha, support over 16.7 percent of the world population. Bamboo provides income, food and housing to over 2.2 billion people worldwide. The National Forestry Action Plan projects states that the total annual requirement of timber in 2001 and 2006 was 73 and 81.8 million m^3 (GoI, 1999) against the available forest stock of 12 million m^3 per annum. Therefore, a huge gap lies between demand and supply. To resolve this, the Government of India started the National Bamboo Mission to promote growth of the bamboo sector, to increase the availability of utility planting material and to strengthen the marketing of bamboo products.

Due to its fast growth, easy propagation, soil binding properties and short rotation, bamboo is considered as an ideal plant for use in afforestation and soil conservation. Long fibre and good working qualities make them suitable for a variety of purposes. Traditionally, entire houses are built using bamboo (without a single iron nail). The tribal communities made large suspension bridges by using cane/bamboos. Bamboos are commoly used as agricultural implements for anchors, boats, bows, chairs, water bottles, ladders, musical instruments, paper, poles, roofing ropes and table mats. In India, *Bambusa polymorpha* is also used for walls, mats, partitions and boards. It is utilized as a raw material for paper pulp. The shoots of bamboo are having low fat and high nutrient content, antioxidants and phytochemical compounds. The market of bamboo is gaining popularity worldwide for its utilization as healthy and nutritious food. The International market for bamboo shoots has grown upto 150 million per year from China alone. *Bambusa polymorpha* is used for building and structural uses, baskets making and making low quality furniture. In recent years, *Bambusa polymorpha* is gaining importance due to its wide acceptance and structural uses.

Conclusion

Bamboos have always been an integral part of the tradional landuse system and domestic life. They are widely distributed in Madhya Pradesh, Northeastern states, Western Ghats and Andaman and Nicobar islands. It provides craftmen nourishment, build roofs and walls of their houses and turn them into bottles to drink. It also plays an important role in soil conservation, their rhizomes firmly holding the top layer soil which prevent soil erosion. Over 1,000 million people live in bamboo houses as the key structural and roofing element. It has been assumed that promoting the use of bamboo as a renewable and sustainable substitute of wood from trees in the form of fuelwood, beams, column, furnitute etc. may reduce the pressure on tree dominated forests.

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POPULARIZATION OF CONSERVATION AGRICULTURE THROUGH AGRICULTURAL EXTENSION SYSTEM

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Soil is the most wonderful gift of nature to human society. Five of the top ten problems facing humanity over the next 50 years (food, water, energy, environment and poverty) are directly related to soil health. Inappropriate agricultural practices, excessive tillage, unsuitable crop rotations, excessive grazing, crop residue removal, deforestation, mining and construction have contributed to soil degradation. There is need to understand and implement sustainable agricultural and land management practices that improve soil health and mitigate change in environment. Many developed countries are following conservation agriculture practices. USA is the pioneer country with highest area under conservation agriculture as compare to other countries. In India, its adoption is still in the initial phase. According to 2018-19 data, the USA has the highest number of acres (108.8 million), followed by Brazil with 106.2 million acres and Argentina with 81.3 million acres cropland used for conservation agriculture (Michaela Paukner, 2022). Spread of conservation agriculture has been made through the combined efforts of several State Agricultural Universities, ICAR institutes. Agricultural extension services are responsible for transfer technologies developed by agricultural research institutes. Extension personnel can follow certain innovative approaches for promotion and adoption of conservation agriculture.

What is Conservation Agriculture (CA)?

Conservation agriculture is a way of farming that conserves, improves and ensures efficient use of natural resources. FAO, 2008 defined conservation agriculture is a concept for resource-saving agriculture crop production system that strives to achieve acceptable profits together with high and sustained production levels while conserving the environment. CA builds ecological foundation for agriculture. It has potential to arrest or reverse land degradation, boost productivity and increases food security. Provides soil fertility, saves money, time and fossil fuel. It is efficient alternative to traditional agriculture.

CA is characterized by three interlinked principles namely minimum mechanical soil disturbance, maintaining permanent organic soil cover and diversified crop rotations. These three pillars ensure improvement or maintenance of soil organic carbon at desired level.

1. Minimum Mechanical Soil Disturbance

Minimum soil disturbance means no tillage/zero tillage. It is way of growing crops or pasture from year to year without disturbing the soil through tillage. No till approach started from 1960s by farmers in India. It is followed in the Indo-Gangetic plains where rice-wheat cropping is present. It has several advantages like reduction in crop duration, reduction in cost of inputs for land preparation, residual moisture effectively utilized therefore number of irrigations get reduced, addition of dry matter and organic matter in soil, reduction in greenhouse effect by carbon sequestration.

2. Maintaining Permanent Organic Soil Cover

A permanent soil cover is important to protect the soil against the deleterious effects of exposure to rain and sun, to provide the micro and macro-organisms in the soil with a constant supply of food and alter the microclimate in the soil for optimal growth and development of soil organisms, including plant roots. In turn it improves soil aggregation, soil biological activity, soil biodiversity and carbon sequestration.

3. Diversified Crop Rotations

Crop rotation refers to recurrent succession of crops on the same piece of land either in a year or over a longer period of time. The rotations of crops are not only necessary to offer a diverse diet to the soil micro-organisms, but also for exploring different soil layers for nutrients that have been leached to deeper layers that can be recycled by the crops in rotation. Cropping sequence and rotations involving legumes helps in minimal rates of buildup of population of pest species, biological nitrogen fixation, control of off-site pollution and enhancing biodiversity.

Constraints in Adopting Conservation Technologies

The most important factor in the adoption of CA is overcoming the bias or mindset about tillage. It is argued that convincing the farmers that successful cultivation is possible even with reduced tillage or without tillage is a major hurdle in promoting CA on a large scale. In many cases, it may be difficult to convince the farmers of potential benefits of CA beyond its potential to reduce production costs, mainly by tillage reductions. CA is now, considered a route to sustainable agriculture. Spread of conservation agriculture, therefore, will call for scientific research linked with development efforts. The following are a few important constraints which impede broad scale adoption of CA.

1. Lack of appropriate seeders especially for small and medium scale farmers: Although significant efforts have been made in developing and promoting machinery for seeding wheat in no till systems, successful adoption will call for accelerated effort in developing, standardizing and promoting quality machinery aimed at a range of crop and cropping sequences. These would include the development of permanent bed and furrow planting systems and harvest operations to manage crop residues.

2. The wide spread use of crop residues for livestock feed and fuel: Specially under rainfed situations, farmers face a scarcity of crop residues due to less biomass production of different crops. There is competition between CA practice and livestock feeding for crop residue. This is a major constraint for promotion of CA under rainfed situations.

3. Burning of crop residues: For timely sowing of the next crop and without machinery for sowing under CA systems, farmers prefer to sow the crop in time by burning the residue. This has become a common feature in the rice-wheat system in north India. This creates environmental problems for the region.

4. Lack of knowledge about the potential of CA to agriculture leaders, extension agents and farmers: This implies that the whole range of practices in conservation agriculture, including planting and harvesting, water and nutrient management, diseases and pest control etc. need to be evolved, evaluated and matched in the context of new systems.

5. Skilled and scientific manpower: Managing conservation agriculture systems, will call for enhanced capacity of scientists to address problems from a systems perspective and to be able to work in close partnerships with farmers and other stakeholders. Strengthened knowledge and information sharing mechanisms are needed.

(Bhan and Behera, 2014)

Agricultural Extension System and Conservation Agriculture

- If Conservation Agriculture is effective, then a key question would be to ask why it is not spreading more rapidly.

- There are number of reasons for farmers not spontaneously adopting CA, despite the acknowledged advantages.
- Agricultural extension services proven better in delivery of information to farmers because of established infrastructure, reach to many people, community trust, cultural awareness, empathy and understanding and more knowledge.
- Farmers presently require a different kind of support from agricultural extension than they received in the past.
- Farmers are the primary decision-makers and movers of change, but they have also suffered because of the adverse impacts of agrarian changes.
- Extension workers need to facilitate farmer self-development through empowering them and helping to improve their ability to manage change.
- Agricultural Extension Agencies and farmers need to receive adequate training and education in CA technologies for sustainable food production.
- As many of the technologies for rain fed agriculture are knowledge-based and need community action, farmers' groups have to be organized and sustained at the grass roots level.
- It is a greater need to emerge new institutional arrangements in partnership with the private sector (input firms, farmers' associations, NGOs, etc.) for providing extension services.
- Extension services should adopt participatory approaches (in technology development and transfer), decentralized planning, managing common property resources, group approaches to technology transfer, wider use of mass media and information and communication technology.

Role of Agricultural Extension Agencies in Popularization of Conservation Agriculture

The agricultural extension agents of different universities, research institutes, KVKs, etc, must play following roles for popularization of conservation agricultural practices,

1. Knowledge disseminator

Knowledge is the main barrier in adoption of conservation agricultural practices. There is a need to think differently about how knowledge is spread to farm families. Additionally new research knowledge on CA systems generated on-farm and on-station is also required to advance their further development and adoption.

2. Educator

Sustainable agriculture production should be featured prominently in the curriculum of colleges and universities. For a broader focus on ecologically-based, resource conserving agriculture based on the core CA principles in all settings for sustaining the production of crops and water from all landscapes.

3. Planner

Planning a programme related to CA technologies like awareness campaign, trainings and demonstration for farmers, youth, SHGs etc.

4. Organizer

Farmers tend to believe trusted peers more than their formal advisers when discussing innovations, making it easy for them to exchange ideas and experiences. Organizing group of such farmers is beneficial. Also organizing training and demonstration to them on CA practices helps to enhance adoption.

5. Demonstrator

Agricultural extension agencies act as a demonstrator for farmers related to relevance and feasibility of CA technologies. Demonstrations should be arranged on farmers field. Example Demonstration of crop residue management technologies.

Farmer to Farmer Extension

Farmer-to-farmer extension may have a role to play in overcoming the information access problems and lack of knowledge that may preclude widespread adoption.

- ✓ First, lead farmer motivation increases their effectiveness at diffusing CA practices to their followers.
- ✓ Second, lead farmer familiarity with and adoption of CA both matter to the spread of CA practices, but familiarity appears more important.
- ✓ Third, lead farmers play a more critical role in increasing awareness than adoption of the CA practices.

(Monica Fisher *et al.*, 2018)

Involvement of Youth

- ✓ The limited involvement of young people in small-scale farming poses a threat to the sustainability of new methods of farming practices such as no-till CA.
- ✓ However, the attitudes of young people towards farming need to be changed, and conditions need to be created that support their entry into farming at an early stage of their lives.
- ✓ Increasing extension contact with farmers is important in influencing the adoption of CA. More young people need to be trained as extension agents.

Conclusion

Conservation agriculture technologies are the future of sustainable agriculture. Conservation agriculture practices such as conservation tillage, residue and land cover management, appropriate crop rotation have shown the proven benefit to improve soil quality across the world. The benefits range from nano-level (improving soil properties) to micro-level (saving inputs, reducing cost of production, increasing farm income), and macro-level by reducing poverty, improving food security, alleviating global warming.

There is need to promote and adopt conservation agricultural practices. Overcome past mindset of farmers and explore new opportunities, crop residue burning, lack of knowledge are the major constraints in adoption of conservation agriculture. Conservation agriculture can be popularized with the help of increasing awareness, giving subsidies on machineries, organizing participatory research and demonstrations and establishing network of practicing farmers. Agricultural extension services play major role in adoption and promotion of conservation agricultural technologies. Agricultural extension agencies and farmers need to receive adequate training and education in CA technologies for sustainable food production. Involvement of lead farmers and young generation in conservation technologies influences adoption of CA.

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SCIENTIFIC CULTIVATION OF FODDER MAIZE FOR ANIMAL HUSBANDRY

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Maize fodder can be grown easily in Indian conditions. Maize is one of the most nutritious non-legume green fodders (Chaudhary *et al.*, 2014). It has high nutritive value, which provides energy and protein to animals. Non-availability of constant quality fodder around the year aggravates the limitations of sustainable dairy farming (Naik *et al.*, 2015). Green fodder is an essential component of the dairy ration; otherwise, the productive and reproductive performance of the dairy animals is adversely affected (Naik *et al.*, 2014). Maize is one of the most suitable crops, having wide adaptability under varying agroclimatic conditions (Sarmini & Premaratne, 2017). Fodder maize contains around 18 to 19 per cent dry matter and around 17 per cent of organic matter. It contains up to 15 per cent of protein and 3.5 per cent to 4.5 per cent of fat. The carbohydrate content in maize fodder is around 15 per cent in green conditions and up to 80 per cent on a dry matter basis. On a dry matter basis, maize fodder contains around 0.35 and 0.14 per cent of calcium and phosphorus, respectively. It suggests that the maize fodder crop has all the characteristics of a good fodder crop, which enhances the milk production and other physiological function of livestock. Maize is an ideal fodder crop because of its quick-growing nature, palatability and excellent quality without any toxicant at any stage of crop growth (Kumar., 2017). A scientific package of practice for fodder maize crops can ensure higher productivity. Loam-to-clay loam soil is suitable for the cultivation of fodder maize. The crop can endure a small level of acidity or alkalinity. The field should have a good drainage facility for the cultivation of maize crops. The crop can be grown throughout the year, except for the extreme winter season.

Cultivation Practices of Fodder Maize for Better Productivity

If maize fodder is cultivated scientifically, then high productivity of the crop can be expected. The detailed package of practices for the scientific cultivation of fodder maize is given in the following paragraphs:

1. Seed requirement and seed treatment: For the cultivation of maize fodder in one hectare of land, 75 to 80 kg of maize seed is required for sowing seed through the broadcasting method and 55 to 60 kg of seed for line sowing. African Tall, J-1006, Vijay composite are some of the important varieties of maize fodder crop. For seed treatment, 2 gm Thiram 75% or 4 gm Carbendazim 50% per kg of seed is required. *Trichoderma viridae* or *Trichoderma harzianum* 2% powder can also be used as bio-pesticide for seed treatment.

2. Application of fertiliser: For per hectare land 150 quintals of farmyard manure, 75 kg urea and 180 kg Single Super Phosphate can be used as basal dose. Potash and zinc may be applied on the basis of requirement. Urea can be applied at the rate of 90 kg per hectare as a top dressing after 30 days of sowing.

3. Irrigation: Seed of maize fodder can be sown in the field with adequate moisture. Irrigation may be provided every 12 to 14 days, except in the rainy season when there is excessive availability of water. Standing water for more than six hours can severely damage the crop, hence good drainage facilities should be there for fodder crop production.

4. Weeding operations: After the sowing of maize seed, in the first-month, problem is less but after one month, a serious problem of weed infestation may be observed. In summer before sowing the crop 2 to 3 deep ploughing may be given. After three days of sowing seed, 10 to 15 gm Atrazine 50% weedicide may be sprayed in the field by dissolving it in 3 litres of water. Weeding can also be done after 30 to 40 days after sowing seeds.

5. Disease management: Among different diseases of maize fodder crops, the fungal disease is the most prevalent. If the seed is treated before sowing, then incidences of disease can be reduced. Apart from that, 3 to 4 gm Mancozeb 75% may be dissolved in per litre of water and may be applied in the field for control of the disease. Spraying Mancozeb 75% again after 10 days of the first spray can give good results.

6. Pest management: Several insect pests damage the yield potentiality of fodder maize crop. Some of the major insect pests of maize are spotted stem borer (Chilo partellus), Pink stem borer (Sesamia inferens), Shoot fly (Atherigona spp.) and Fall Army Worm – (*Spodoptera frugiperda*). Spotted stem borer, Pink stem borer and Fall Army Worm generally attack the plant in the initial phase of growth and cause extensive damage within the initial 40 days of germination. These insects can be controlled by spraying 5 per cent neem oil (Azadirachtin) by dissolving at the rate of 1500 PPM in per litre of water. As the crops are grown for animal feeding, chemical pesticides may be avoided for controlling insect pests. In case of more than 10 percent infestation, Chlorantraniliprole 18.5 SC, Emamectin Beazoate 5% SG or Spinetoram 11.7% SC can be applied. The fodder can be harvested at least 30 days after the application of chemical insecticide.

7. Harvesting: The fodder maize can be harvested after 50 to 75 days after sowing with the emergence of the male flower to milk stage. Fodder should be cut into small pieces to feed to animals. The average yield of fodder maize is 250 to 350 quintals per hectare.

Conclusion

For animal husbandry, feeding is the most important aspect. Animal feeding involves around 60 to 70 per cent of total farm expenditure. Maize is considered one of the best fodder crops for animal husbandry. The yield potentiality of fodder maize can be enhanced by following the proper package of practices. Maize fodder can provide enough energy, protein and other nutritional elements which can improve the productivity of livestock. Hence, the cultivation of maize fodder crops scientifically can increase the economic return of animal farms.

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