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EDITORIAL

The modern agricultural practices which are heavily dependent on the use of chemical pesticides, inorganic fertilizers and growth regulators have raised the agricultural production manifold but at the cost of resource depletion, environmental deterioration and loss of crop diversity. Therefore, it was realized that modern agriculture is not sustainable in the long run; hence, the concept of sustainable agriculture emerged which not only emphasizes on the conservation of natural resources but also maintains the quality of the environment. Sustainable agriculture is in fact the successful management of resources for agriculture to satisfy the changing human needs, while maintaining or enhancing the quality of environment and conserving the natural resources. It is a balanced management system of renewable resources including soil, crops, livestock, plant genetic resources, wildlife, forest and ecosystems without degradation. It also endeavors to provide food and livelihood to the masses along with maintaining and improving crop productivity and ecological system.

The regeneration of agriculture is need of hour and strategies with determination are needed for saving the planet. In this direction, Natural Farming is playing an important role with a diversified farming system which integrates crops, trees, livestock and allows the optimum use of functional biodiversity. Natural Farming is defined as 'chemical-free and livestock based farming' and considered a form of regenerative agriculture. Natural farming is not a technique but way of seeing ourselves as a part of nature, rather than separate from nature. It is also referred as 'the Fukuoka Method' or 'the natural way of farming'.

Government of India is promoting Natural Farming as 'Bharatiya Prakritik Krishi Paddhati' (BPKP) under the centrally sponsored scheme Paramparagat Krishi Vikas Yojana (PKVY). BPKP aims at promoting traditional indigenous practices which are largely based on on-farm biomass recycling with an emphasis on mulching and use of cow dung and urine formulations. It excludes all synthetic chemical inputs. Natural Farming focuses on promoting traditional indigenous cow based agricultural practices which gives freedom to farmers from externally purchased inputs. The vision is to implement sustainable natural farming systems with the aim to cut down on cost of cultivation, enhance farmers income, ensure resource conservation and safe & healthy soils, water, environment and food. Currently several states are undertaking Natural farming through central programmes like RKVY, PKVY, BPKP and others state specific programmes.

It was stated in the budget announcements that natural farming will be promoted throughout the country, with a focus on farmers' land in 5 km wide corridors along river Ganga, at the first stage. This initiative will supplement the efforts initiated under National Mission on Clean Ganga for maintaining the cleanliness of the Holy River as well as helping farmers in getting premium price for their organic produce. It was also announced that States will be encouraged to revise syllabus of agricultural universities to meet the needs of natural, zero-budget and organic farming, modern day agriculture, value addition and management. In this connection, Indian Council of Agricultural Research (ICAR) has constituted a committee for development of syllabus and course curriculum for integration of natural farming in existing UG and PG programme and also suggest new courses to be launched. ICAR has recently notified a dedicated postgraduate course in chemical free organic farming.

Natural farming has five components viz. (i) stimulation of microbial activity to make nutrients available to crop and protection against pathogens using a microbial inoculum, 'jiwamrita'; (ii) protection of young roots from fungal and soil-borne diseases using another microbial culture, 'beejamrita'; (iii) production of stabilized soil organic matter and conservation of top-soil by crop residue mulching, (acchadana), (iv) soil aeration (whapahasa) by improving soil structure and reducing tillage and (v) multiple cropping for round the year production and pest control.

Promotion of Natural Farming is expected to bring in a new era in the field of agriculture leading to sustainability of the system, natural resource conservation, soil health rejuvenation, harnessing the potential of so-far unexplored desi cow and move towards a regime which gradually helps in reduction of chemical fertilizers and making agriculture sustainable in the long run. Besides, natural farming also ensures safe and healthy food free from chemical residues.

Dr. Sanjay Kumar Joshi

System of Wheat Intensification (SWI)

Pooja and Janardan singh

The System of Wheat Intensification (SWI) is a revolutionary wheat establishment approach that incorporates sowing, weeding, irrigation, and nutrient management practices. These management approaches improve the root zone growth of wheat plants compared to those cultivated using traditional wheat cultivation practices. SWI is a new wheat-growing potential that can immediately enhance farmer income and minimize food insecurity for small and marginal farmers. It may help the crop endure biotic and abiotic challenges that are getting more severe as a result of climate change. By reducing agricultural input costs, SWI can help resource-poor farmers enhance productivity and profit.

The Principles of System of Crop Intensification (SCI), an innovation that allows for higher production per unit of agricultural inputs such as fertiliser, seed and other such items. Results gained by using the system of wheat intensification (SWI) or SCI principles in wheat cultivation are encouraging. The concepts of early and healthy plant establishment, reduced plant competition, enhanced soil organic matter, active soil aeration and cautious water application are all contributing to increased agricultural productivity and profitability. Changes in crop management have proven beneficial to food security in India and Ethiopia, and are now being scaled up with hundreds of thousands of farmers. Although this SCI production technique is 'labour intensive,' households seeking to acquire the most output from the little plots of land accessible to them discover that the extra time and attention improve net returns and livelihood stability. As a result, crops are more robust, resistant to insect and disease as well as unfavourable weather circumstances. Smallholder farmers in many countries have started to gain higher yields and productivity from their land, labour, seeds, water and capital by using SCI approaches, with crops demonstrating improved resilience to climate change threats. With the foregoing in mind, a carefully organized experiment was carried out to compare and confirm the performance of traditional better methods and SWI practices in order to validate the concepts of SWI and give supporting empirical data.

Principles of SWI

SWI is primarily based on two principles of crop production:

1. **Principle of root development:**

Root development is the initial phase in a plant's healthy growth and development. When seeds are placed closer in the conventional wheat production method, their roots compete for nutrients, water, and sunlight. Due to the increased weed population, competition with weeds is also widespread. Because of the narrower spacing, root growth is inhibited and the wheat crop fails to restrict the growth of emergent weeds in the field. Their root system is underdeveloped, which has an impact on tillering capacity and biomass yield. But in case of SWI, plants are spaced wide (20 cm from each other) and mostly in a square pattern. Wider spacing (20 cm × 20 cm) can later

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yield even higher yields as SWI practice improves the soil over time. Sparse planting prevents root growth inhibition caused by crowding. SWI also creates the edge effect (border effect) for the entire field by exposing plants to more light and air. Farmers can weed their fields in perpendicular directions by planting in a square pattern, which results in more and better soil aeration. Furthermore, a competitive wheat stand that has a head start on weeds will suppress weed growth. When wheat plants are planted far apart and the soil conditions are favourable, their roots will have plenty of room to spread out and will not compete with one another. As a result of having more access to both oxygen and water under aerobic conditions, the wheat plant produces not only more tillers but also a larger volume of root.The structure and functioning of soil biota, nutrient status & cycling and root system may be affected by SWI practice due to aerobic soil conditions.

2. Principle of intensive care:

Weed competition, multiple nutrient deficiencies, insects-pests and disease incidence are all major hindrances to higher wheat productivity. As a result, increasing productivity necessitates meticulous attention at every stage of plant development, particularly in terms of organic manure, irrigation, weed, insect and disease management. The following SRI core principles developed for rice are used in the SWI cultivation method.

i) Seed priming, including seed selection and treatment.

ii) In the field, single plants are spaced widely and uniformly in a square pattern (starting at 20cm x 20cm and going up to 50cm x 50cm).

iii) Mechanically suppressing weeds rather than chemically or by hand to increase soil aeration by 2 or 3 times.

The other crop husbandry practices are similar to those used with traditional wheat cultivation methods. (careful transplanting of 8-12 days old seedlings at wider spacing; intermittent irrigation for keeping the soil moist to the point of surface cracking; weeding is started about 10 DAT, with at least 2 weeding; compost is used instead of chemical fertilizer).

Production Technology For SWI

The System of Wheat Intensification involves the following modified practices for achieving higher productivity:

1. Seed Treatment: To control seed-borne fungal diseases, seeds are treated with Bavistin or Vitavax. For increased microbial activity in the soil, seeds are also treated with an organic mixture of well decomposed compost, jaggery and cow urine.

2. Seed Treatment Procedure: Fill an earthen pot with 10 litres of hot water (60 degrees Celsius) and 5 kg of pure seeds. Remove any seeds that float on the water.

After that, combine 2 kg of jaggery, 3 litres of cow urine, and 2 kg FYM with the seeds. Then leave

the material in the shade for 6-8 hours. After 6-8 hours, the seeds were separated into solids and liquids. After that, apply 10 gm of fungicide to the seeds and leave for 10-12 hours.

It should be used for sowing after the seeds have germinated.

3. Seed Rate: Under SWI, seed rate is reduced to 20-25 kg per ha, whereas traditional methods require 100-125 kg of wheat seed per ha. Sowing treated seeds in lines 20-25 cm saves a large amount of seed and lowers cultivation costs.

4. **Line Sowing:** Maintaining plant to plant spacing is critical for proper root development and tillering in wheat crops. Two seeds are sown per hill, with a 20 cm x 20 cm spacing between row to row and plant to plant. Seeds should be sown at a depth of 2.5–3 cm using a seed drill. The availability of moisture in the field is critical for seed germination.

4. Gap Filling: If the seeds have not germinated, resowing with germinated seeds should be done within 10 days of seed sowing. If two seeds germinated in the same hill, one plant should be uprooted to ensure proper growth.

5. Irrigation: Root initiation begins after 15 days of sowing, and the first irrigation is given during this time. Root initiation is hampered by a lack of moisture in the soil. The second irrigation is given 25 days after sowing, when the tillers begin to emerge. The third irrigation is given after 35- 40 days of sowing. Following that, irrigations are given at 60, 80, and 100 DAS. During the flowering and grain-filling stages, the soil should have enough moisture.

6. Weeding: Hoeing and weeding should be done with the cono-weeder after the first, second, and third irrigations. It aids in soil detachment as well as weed control in the field. This practice improves root length by increasing soil aeration in the root zone. This promotes the growth of more vigorous tillers in the plant.

7. Crop Rotation with Legumes: Wheat rotation with legumes such as soybeans and pulses improves wheat productivity by increasing soil nutrient levels and improving soil productivity. Wheat crop yields are improved by legume rotation because legumes aid in nitrogen fixation and improve soil fertility and productivity.

8. Management of Organic manure/FYM : If organic manures are used to meet nutrient requirements, nutrients are released slowly, in small amounts and without variation. As a result, nutrients are available for a longer time. FYM is a very effective way of manuring because it increases microbial activity in the soil. The following factors should be considered while making compost:

- In case of FYM, protection from rainwater is critical because it leaches nutrients; additionally, FYM should be protected from sunlight to avoid ammonia volatilization.

Package of practices for SWI

• Cattle urine should be properly collected and utilised.

• FYM should be thoroughly mixed into the soil.

9. Land preparation: Before 15- 20 days of sowing, 0.4 ton vermicompost or 2.0 ton FYM per acre must be mixed thoroughly in the land. Ploughing is also important before sowing if there is no moisture in the soil. 27 kg DAP and 13.5 kg potash per acre should be broadcast before last ploughing to meet out the nutrient requirements. It has been discovered that nutrient decision support systems such as "Nutrient Expert" can estimate the demand for both organic and inorganic fertiliser at the time of field preparation.

Comparison between conventional method and SWI

Particulars	Conventional method	SWI
Seed treatment	Not done	Done with warm water, cow urine, jaggery, vermicompost and Trichoderma
Seed rate (kg/ha)	100-125	20-25
Sowing	Broadcasting	Line sowing
Spacing	22.5 cm	20 cm × 20 cm
Weeding or hoeing	No weeding	3 times

Advantage of SWI

The SWI method reduces capital, fertiliser, labour and water inputs while increasing crop yields. Additionally, this method encourages the abundance, diversity and activity of soil biota in and around the plant's rhizosphere zone. These modified practices with lower inputs, combined with good aeration and soil organic matter, result in an overall increase in crop productivity.

SWI constraints

- Need to design and develop appropriate sowing implements.
- Building farmer capacity for SWI adoption.
- Ensure irrigation during critical stages of crop development.
- A research station must conduct extensive scientific research.

Conclusion

SWI is a new wheat-growing opportunity that can directly increase farmer income and reduce food insecurity for small and marginal farmers. It may help the crop withstand biotic and abiotic stresses that are becoming more severe as a result of climate change. SWI can help resource-poor farmers increase productivity and profit by reducing agro-input costs.

Rabi maize (*Zea mays* L.): A Boon crop to the farmers

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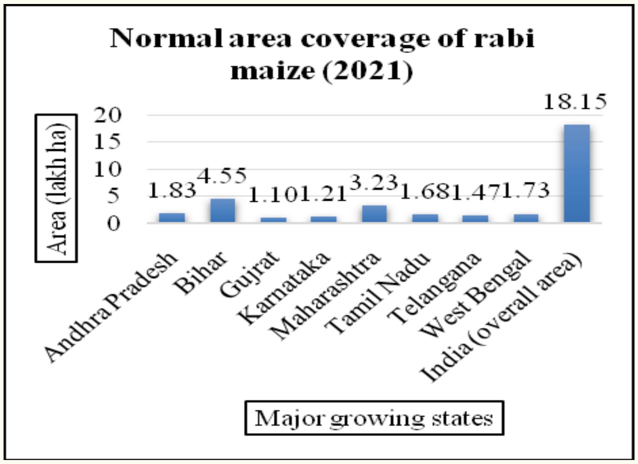
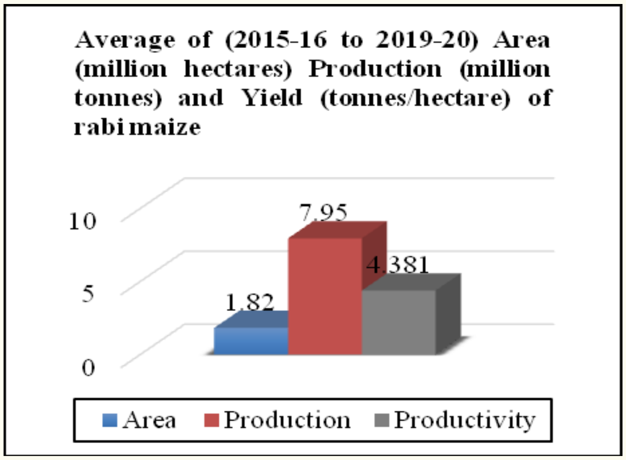
Maize (*Zea mays* L.) is one of the most important cereal crops, which has a wider range of adaptability under various agro-climatic conditions. Maize is known as the queen of cereals globally because it has a wide genetic yield potential. Maize is the third-most significant food crop after rice and wheat in India. In India, maize is grown throughout the year in the majority of the states. India is fourth in area and seventh in production among nations that cultivate maize and share about 4% of the global area and 2% of total production. The average productivity of Indian maize is comparatively lesser than that of other countries. In India, the area covered by maize in 2022 was 9.86 million hectares and production was 31.51 million tonnes. In India, rabi maize is grown on 1.82 million hectares of land and produces 7.95 million tonnes, and the average productivity of *rabi* maize (4318 kg ha^{-1}) is higher than that of *Kharif* maize (2516 kg ha^{-1}). The states that cultivate the most *rabi* maize are Andhra Pradesh, Bihar, Gujarat, Karnataka, Maharashtra, Tamil Nadu, Telangana, and West Bengal. Maize is used as a basic raw material of industrial products, including starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries, in addition to serving as a staple food for humans and high-quality animal feed. In addition to its significance among food grains, maize is crucial to India's agribusiness value chain's overall development. It is necessary to know the economics





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of supply and demand for maize both in national and global level.

Reason for higher yield of rabi maize than kharif maize

Although the crop responds better in the *rabi* season than in the *kharif*. In the *kharif* season, the southwest monsoon's unpredictable rainfall pattern, pest infestation, high temperature and weed infestation hinders timely field activities and crop growth. But in the *rabi* season, the establishment of the optimum plant population can be ensured due to improved soil, water management and less damage from diseases and pests. The climatic factors like availability of 7-9 or more hours of sunshine during the *rabi* season, as opposed to 3-5 hours during the *kharif* season as well as optimum temperature for growth collectively contribute for increasing maize yield in *rabi* cropping season.

Management Practices

Suitable Varieties of Rabi Maize
Buland, Pratap, PMH 9, Rajendra hybrid makka-1, DHM 103, DHM 105, Ganga 11, ICI 705, Dhawal, Laxmi, Devaki, Sheetal, Proagro 4212, Praval, Rajendra hybrid 1, Rajendra hybrid 2, Pro311, Seed Tech 2324, Hemant, Saktiman 1, Saktiman 2, Saktiman 3, Saktiman 4, Ganga Safed 2, Pioneer 30, V 92, Bio 9681, HM 1, HM 2, HM 8, HM 11

Rabi maize varieties

Maize hybrid or composite varieties to be grown has a significant impact on the yield and profit. Therefore, it is important to encourage farmers for sowing of high-yielding hybrids during the *rabi* season. In most cases, hybrids produced 60 to 80 percent more grain than the local types and average yield of hybrid varieties is 4-6 tonnes or more per hectare.

Soils

Maize is grown in a wide range of soils from sandy to loamy soil. The best-suited soil for maize cultivation is silt loams and deep loams with sufficient organic matter and nutrient-rich soil that are well-drained and aerated. The saline, acidic, alkaline, and waterlogged soils should be avoided for the cultivation of maize crop.

Sowing time

The optimum time of sowing is important for winter maize so that crop can complete its life cycle in a favourable environment. In general, sowing should be done in mid-October, ideally by the end of October. Most of North India experiences a relatively abrupt temperature decrease from the second week of October to mid-November, which delays germination and severely hampers plant growth. Therefore, significant delay in sowing leads to reduced yield. Further, common rust infestation is more in late-sown crops than in timely-sown crops.

Seed rate and plant population

To achieve maximum grain yield of maize, the population should be 90,000 plants per ha. The ideal plant population is maintained with row to row distance of 60 cm and plant to plant distance of 18–20 cm. One hectare of land would require 20-25 kg of maize seed. The seed should be soaked in warm water for at least eight hours prior to sowing (water temperature at the time of seed soaking should be 45^0c). This treatment aids in generating a healthier harvest and improved plant stand. The depth of seed sowing should be 4-5 cm. The seed should be treated with fungicides and insecticides to minimize the disease and insect incidence.

Sowing method

The majority of maize is planted directly through the seed using various techniques. Resource conservation technologies (RCTs), which are used in a variety of maize-based cropping systems including surface seeding, zero tillage and minimal tillage, are envi-

ronment friendly and economical.

Raised bed planting

It is the ideal method for planting maize throughout the monsoon and winter seasons, in both the situations of high rainfall and restricted irrigation supply. To ensure good germination, sowing should be done in the southern side of east-west direction on the ridges and beds. Raised bed planting technology can increase production while saving 20-30% of irrigation water.

Sowing with zero till

Maize can be sown successfully without any prior tillage in a no-till environment with less cost of cultivation, greater profitability and more effective resource management. In zero tillage, it is important to ensure that the soil is adequately moist before sowing the seeds and fertilizer should be applied using a furrow opener and fertilizer planter.

Conventional till flat planting

In high weed infestations where chemical or herbicidal weed management is uneconomical in no-till, as well as in rainfed places where crop survival depends on retained soil moisture, flat planting can be accomplished with seed-cum-fertilizer planters.

Furrow planting

This technique is used to reduce moisture stress on crops by reducing evaporative loss of water throughout the crop season from the soil under flat and raised bed planting. Sowing of maize in furrows is advised under these circumstances for proper growth, seed setting and increased productivity.

Intercropping

Maize is one of the most adaptable crops for growing intercrops, giving farmers a larger revenue. Short-duration varieties of pulses (pea, rajmash and other beans), most vegetables, and oilseed crops (soybean, linseed) can be successfully intercropped with maize. Although there is an intercrop, the output of pure maize is not reduced. Maize cultivars with shorter statures perform better when intercropped.

Nutrient management

The amount of fertilizers that need to be applied primarily depends on the soil's fertility and previous field management. Therefore, it is advised to apply 10 t FYM ha^{-1}at15 days before planting and apply 150-180 kg N, 70-80 kg P_2O_5, 70-80 kg K_2O, and 25 kg $ZnSO_4$ ha^{-1} for the greater economic yield of maize. The full doses of P, K, and Zn should be applied as a basal, preferably by seed-cum-fertilizer drilling machine in bands along the seed. 1/3 N should be applied at the time of sowing and 1/3 N should be applied at the knee-high stage (30-35 days) and the remaining 1/3 at the pre-tasselling stage (50-55 days).

Water management

Rabi season maize crop requires four to six irrigations for proper growth and development. In maize crop, maintain the soil moisture availability of 70% during the crop growth and development period when soil typically light. For the best yield in heavy soils, the moisture level should be 30% during the vegetative stage and 70% during the reproductive and grain-filling stage. The most sensitive stages for water stress are young seedlings, knee-high stage, flowering and grain filling, so irrigation should be given at these stages.

Weed management

Light hoeing should be applied as and when needed. Pre-emergence spraying with Atrazine @ 0.5-1.0 kg a.i. ha^{-1} in 1000 lit. of water effectively suppresses most grasses and broad-leaved weeds. Pre-plant applications of non-selective herbicides, such as glyphosate at 1.0 kg ha^{-1} in 400-600 litres of water or paraquat at 0.5 kg a.i. ha^{-1} in 600 litres of water is advised in zero-till maize production to suppress weeds. Paraquat post-emergence application may also be carried out as a covered spray when there is a significant weed infestation.

Plant protection

Pest management

Major pest in India is stalk borer (*Chilo partellus*), Shoot fly *(Atherigona sp.*), Termite, Red hairy caterpillar during *Kharif* and *Sesamia inferens* during r*abi* are the most serious pests and cause yield loss of 25-80% during severe conditions. Fall army-worm (*Spodoptera frugiperda*) an invasive pest was

first reported in India during *Kharif* 2018, and caused heavy damage. Growing resistant and tolerant variety against the insect and changing the time of sowing avoid infestation at the critical stage. Intercropping with legumes such as cowpea, soybean, redgram and greengram encourages the population of natural enemy of insects. Trap crops like sorghum have shown encouraging results in pest control. Release of egg parasitoid, *Trichogramma chilonis*@ 8 cards per ha twice *i.e.,* at 12 and 22 days after germination is beneficial. Use of recommended dose of fertilizers and avoiding excessive use of nitrogen helps in management of sucking pests.

Disease management

In India, the maize crop is affected by several diseases like Downey mildew (*Pernosclespora phillippinesis*), Stalk rot, Leaf blight, Maydis leaf blight. Growing resistant and tolerant variety against the diseases is beneficial. Seed should be treated with fungicide before sowing for management of seed borne diseases.

Harvesting

The grain-producing maize crop is harvested when the grains are almost dry and have less than 20% moisture content. In case of high-yielding hybrids and composites, where the grains are dried but the stalk and leaves appear green, the appearance of the plant could be confusing. So, more emphasis is given on hardness of grains. In the standing crop, cobs are cut off. Before shelling, harvested ears are dried in the sun. After harvesting the cobs, maize stalks are used as animal feed. No portion of the maize plant is wasted not even the cobs from which the grains have been removed. In order to maximize yield and protein content, corn produced for fodder should be collected between the milk and early dough stages. But the late dough is better for silage. There are inexpensive hand and power-driven maize cob-sheller used for the threshing. Compared to the common methods of beating with sticks or shelling by hand, the power-driven shellers are significantly more efficient for removal of grains from the cob.

XYZ System of Hybrid Seed Production in Wheat

Rajesh Panchal and Raval Kalpesh

Wheat is a member of grass family generally cultivated for its seed, a cereal grain which is staple food worldwide. There are so many species of the genus *Triticum*; the most widely grown is *Triticum aestivum* (bread or cultivated wheat). Botanically wheat fruit is 'Caryopsis'. Since green revolution, production of wheat and other food grains have increased triple fold and it is expected to increase further in the mid of 21st century. Demand of wheat and other food grains are increasing globally day by day due to increasing population. Besides this, unique properties of gluten protein *i.e.* viscoelastic and adhesiveness, help in processed food production in easy and simple way. Due to worldwide process of industrialization and western diet habit, consumption of processed wheat product is increasing.

A hybrid is a progeny obtained through crossing or inter-mating between two different parents, those may be from same species or different species. The superior performance of hybrid is known as hybrid vigour or heterosis, which is generally expressed in terms of yield or other related characteristics. The development of hybrid was not feasible earlier; it has been now an interested area of research for plant breeder.

The wheat produced through hybridization has various improved character over non-hybrid wheat *viz*., 10 to 20 % yield advantages over the existing highest yielding pureline, better quality of grain & straw, responsive to fertilizers, better penetration of roots and better grain filling. The hybrids have higher suitability as compared to existing purelines, so hybrids may be suitable for various range of environments. In winter wheat, heterosis has also been reported for tolerance against various stresses *i.e.* frost, leaf rust, stripe rust, blotch and powdery mildew. Therefore, for hybrid wheat, it may be desirable to combine multiple partially dominant alleles of most favourable genes including those involved in epistatic interactions.

In wheat, initial programmes were based on Cytoplasmic Male Sterility (CMS), which were generally unsuccessful and could not be exploited for production of commercial hybrid wheat for a variety of reasons. Although efforts of utilization of CMS and restore based on it, are being utilized by involving *T. timopheevi* and *Hordeum chilense* (*msH1*) at CIMMYT and Europe, respectively. But, information regarding use of *msH1* in recent is yet missing.

Hybrid wheat in India

A network project for hybrid wheat seed production by involving CMS based system was initiated in India in the year of 2009 by ICAR, though no any considerable achievement was identified. In the year 2002, a private seed company in India, MAHYCO released two CMS based wheat hybrids *i.e.*, Pratham 7070 and Pratham 7272; and they had occupied more than 60,000 acre of area in six states of India since

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2004, but unfortunately they were discontinued as they were not comparable with recently evolved wheat purelines. A plant breeder and some of private institutes are now taking interest for development of hybrid wheat based on MS systems and aiming to get yield advantages over the recent best performing purelines of wheat. So, development of wheat hybrid for commercial purpose will take time in our country.

Possible way of Hybrid Wheat Production

In any hybrid seed production programme, there is requirement of out-crossing and this can be achieved through natural emasculation mechanism or manual emasculation. Manual emasculation is not economically feasible for commercial hybrid production whereas natural emasculation is available through various ways; one of the most important approaches is male sterility. In this approach, female parent must be male sterile.

Male sterility in wheat is mainly achieved through followings:

1. CMS and fertility restoration (three line A, B & R system)
2. Induced male sterility and two line system [CHA induced male sterility, Photoperiod Sensitive Cytoplasmic male sterility (PCMS), Thermo-sensitive recessive male sterility (TGMS), Photoperiod and temperature sensitive genic male sterility (PTGMS)]
3. Genetic male sterility (GMS)
4. Chromosomal male sterility (ChMS): XYZ-ms system
5. Transgenic male sterility

Considerable research has been done in the study of these approaches; the progress made in Chromosomal Male Sterility is given in detail.

Chromosomal male sterility (ChMS): XYZ ms system

In wheat, first time in 1972 Driscoll had proposed XYZ system of seed production. This system involves a factor that causes sterility is chromosomal rather than cytoplasmic or genetic or both. It involves a gene for male sterility, ***ms***, on wheat chromosome and the respective gene for fertility restorer, ***Ms***, on a homoeologous chromosome which is derived from a related species of wheat. The alien chromosomes bearing a marker gene, does not pair with any of the wheat chromosomes.

The system of hybrid seed production suggested by Driscoll in wheat is based on CMS approach and involve three diverse lines *viz*., X, Y and Z. Generally, in any hybrid seed production programme, female parent used is male sterile from which seeds are only harvested whereas, male parent is best performing and fertility restorer type cultivar. All the three lines of this XYZ system are recessive homozygous for male sterility factor *i.e.*, ***ms1*** allele. Besides this, to hinder the activity of ***ms1*** allele, a male fertility allele ***Ms1*** which is dominant over ***ms1*** is transferred by involving alien chromosome carrying this dominant ***Ms1*** allele. As per previous reports, the chromosome complement for dominant allele ***Ms1*** for X, Y and Z lines will be ***Ms1/Ms1***, ***Ms1/-***, ***-/-***, respectively; suggesting that X, Y and Z has two, one and zero dose of male fertility allele ***Ms1.*** Due to these chromosomal constitution, X and Y lines are male fertile and Z line is male sterile; and so, it is used as female parent in hybrid wheat production.

The system will be exemplified by ***ms*** mutation on a group 5 chromosome of wheat and chromosome 5R of rye *(Secale cereale* L.), which possesses the responding ***Ms*** gene and the marker gene hairy peduncle, ***Hp***. The gametes produced and breeding behaviour of all the three lines is shown in table.

	X line **21" wheat + 1 " alien**	**Y line** **21" wheat + 1' alien**	**Z line** **21" wheat**
Genotype	ms/ms MsHp/MsHp	ms/ms MsHp	ms/ms
Egg	Ms MsHp	ca. 25 % ms MsHp ---------------- 75 % ms	Ms
Functional Pollen	Ms MsHp	Ms	None
Offspring (selfed)	ms/ms MsHp/MsHp	ca. 25 % ms/ms MsHp ---------------- 75 % ms/ms	None

The X line, which possesses a pair of alien chromosomes (here rye chromosome), produces only one type of gamete and is true breeding line. The Y line produces two types of eggs and one type of pollen. So, the ***ms*** allele will be functional in sporophytic tissue and not on gametophyuc tissue. In this, alien chromosome is necessarily required for normal anther development, but it is eliminated due to pollen grain deficient of alien chromosome. That is why selfed progeny obtained from Y line or Y type of plant will be mixture of Y plant (25 %) and Z plant (75 %). The Y type plant will exhibit hairy neck. The Z line will produce only one type of egg and no functional pollen, which is obtained through selfing of Y line.

The fundamental necessity for hybrid wheat production is to procure large and homogenous population of Z line. It can be obtained as per shown in Fig 1.

It should be clear in mind that amount of rouging will be small and it is practiced in one selfed generation of Y line. This can be achieved by recycling of Z lines by pollinating it with X and Y lines as in Fig 1 and increase amount of Z seeds without rouging. This will lead to development of product without alien chromosome. Here effect on agronomic traits is not taken into consideration. In the final and last step, normal wheat variety with ***Ms/Ms*** is used to fertilize Z line and resulting seed will be hybrid and male fertile.

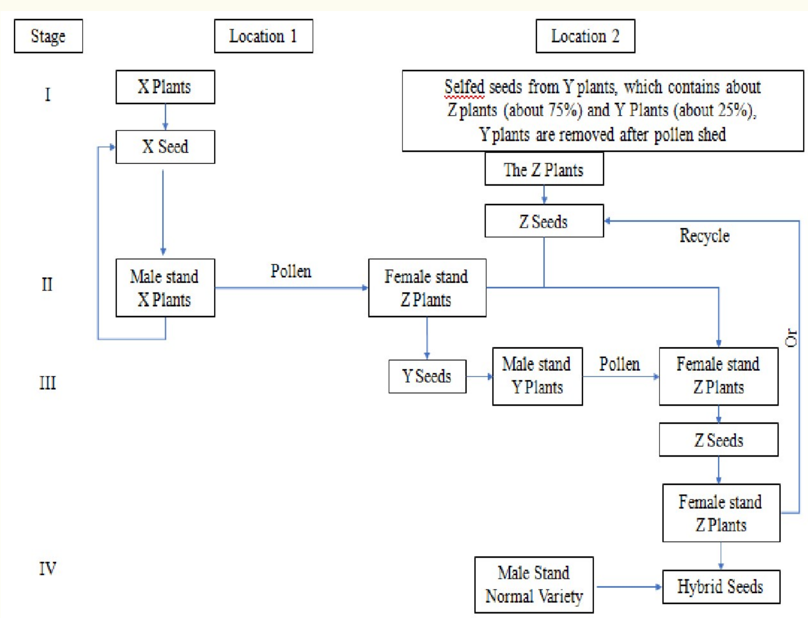

Fig 1: Steps of the production of XYZ line and hybrid wheat

In this programme, Y line is monosomic for alien chromosome that can be easily distinguishable through marker gene and is used to produce male sterile Z line by adopting selfing of Y lines. Whereas, X line is disomic for alien chromosome, which is having higher amount of marker gene expression as compared to Y lines, so it should be discarded. The marker gene should be easy to identifiable.

One of the widely used marker gene is ***Ba*** (giving blue aleurone colour in wheat) by involving alien chromosome 4E from *Agropyronelongatum*, carrying dominant allele ***Ms1***. A main drawback of using ***Ba*** is that the grains having single dose of allele for blue coloured aleurone will express weak blue colour, therefore distinguishing is inefficient. So, it is not under common use. In principle, however, the hybrid production is bit easy and accountable. And that's why examination is carried out to determine the practical efficiency of this method.

An amylose content can also be used for grain sorting marker. A waxy wheat has null ***wx-A***, ***wx-B*** and ***wx-D*** alleles which are responsible for zero amylose content in wheat. For semi-waxy wheat, the amylose content is 18 to 20 % when the functional gene of sub-genome D is accumulated in homozygous condition. In heterozygous condition, the wild type female (wt) donor have 13 to 15 % amylose content and the male have 7 to 8 % amylose content. Therefore, the dosage effect is about 7 % amylose for a single gene. The particular allelic or genetic assembling leads to different classes, but use of single kernel near-infrared spectroscopy for efficient sorting of grain has been now available.

A good combiner elite wheat line is used as the male parent. Accounting that, XYZ system provides a highly stable and pure genetic male sterile line, which otherwise timing process to produce and maintain as in case of GMS. In future, the ChMS system may be used for commercial wheat hybrid production.

Improved Cultivation Technologies of Groundnut in Rabi Season

Aditya Kumar Singh[1], Dr. Narendra Singh[2], Dr. H.S. Kushwaha[3]

Groundnut or Peanut (*Arachis hypogaea*) is an important oilseed crop in India and covers an area of 5.85 m ha with production of 8.26 m tons. The major groundnut growing states in India are Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Rajasthan, Madhya Pradesh, Odisha, and Uttar Pradesh. Groundnut is a species in the legume or "bean" family which was probably first domesticated and cultivated in the valleys of Paraguay. It is an annual herbaceous plant growing 30 to 50 cm (1.0 to 1.6 ft) tall. It is also known as peanut, monkey nut or moongfali. Botanical name of groundnut is *Arachis hypogaea* which is derived from Greek word *Arachis* means legume and *hypogaea* mean below ground, referring to the formation of pods in the soil. It plays an important role in the dietary requirement of poor women and children. Groundnut kernels are also used for preparation of food products like chikkis, groundnut milk, butter, curd including different bakery products. After extraction of oil, groundnut cake is used as valuable organic manure and feeding material for livestock. It consists of 7.3% N, 1.5% P_2O_5 and 1.3% K_2O. The peanut haulms contain crude protein 5%, lipids 1–3% and minerals 9–10%. These are used as cattle feed either in fresh/dried stage or preparing hay/silage.

The peanut shells or pod walls which constitute nearly about 25% of total pod weight are used as bedding material for poultry or as mulching material during the summer season to reduce the evaporative losses. Shell material is also used as filler material for making mixed fertilizers and as insulation material for buildings or as fuel in boilers.

Soil

Well-drained, sandy loam soil, supplied with calcium and moderate amount of organic matter is suitable for groundnut cultivation. In Odisha, such soil is found in flood receded river valleys of the coastal districts. These soils are ideally suited for cultivation of rainfed rabi groundnut. The optimum soil pH for groundnut cultivation is 6.0 to 6.5, however, a range of 5.5 to 7.0 is acceptable.

Field preparation

Plough the field 2 to 3 times at optimum soil moisture to secure good surface tilth to a depth of 15 cm. Planking should be followed after each ploughing to conserve moisture. Use improved plough (MB plough/cultivator or rocket plough) and power tiller with motivator or tractor with cultivator for good seed bed preparation. A good seedbed has great signifi-

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High-yielding varieties of Groundnut

Variety	Habit	Duration	Average yield (q/ha)	Shelling (%)	Oil content (%)	Special character
AK12-24	Bunchy	105	16.00	70	48	Resistant to leaf spot and rust, seeds rosy in colour having no dormancy
Smruti OG52-(1)	Bunchy	110	25.00	72	51	Kernel bold, red in colour, resistant to collar rot and stem rot, no dormancy.
TAG 24	Bunchy	110	25.00	72	53	Resistant to bud necrosis, leaf spot.
ICGS 11	Bunchy	125	25.00	70	53	Plants are dwarf with dark green leaves.
TMV 2	Bunchy	115	16.00	70	51	Seeds salmon in colour spheroidal in shape, moderate resistant to early, late leaf spot and rust dormancy absent.

The main Groundnut varieties produced in India are Kadiri-2, Kadiri-3, BG-1, BG-2, Kuber, GAUG-1, GAUG-10, PG-1, T-28, T-64, Chandra, Chitra, Kaushal, Parkash, Amber.

cance for successful groundnut cultivation as it allows early root penetration and easy pegging and pod formation. The weeds and stubble of the preceding Kharif crop should be collected and destroyed. Apply FYM or compost @ 5.0 t/ha and incorporate it before final land preparation. Use insecticide at final land preparation in termite prone fields.

Scope for the lime application does not exist in rabi groundnut raised on residual soil moisture. However, lime can be applied in acid soils under irrigated conditions. Apply lime as per soil test result or @ 1.25 t/ha at least one month before sowing.

Seed treatment

Treatment with organomercurial compound should not be done when the seeds are treated with Rhizobium culture. Rhizobium culture treatment should be taken up after seven days of the seed treatment with the mixture of carbendazim 0.1%+thiram 0.15% or with (carboxyn 37.5%+thiram 37.5%) @ 0.15%. Add sodium or ammonium molybdate @ 3g/10 kg

kernel along with bacterial culture. About 1.5 kg of Rhizobium culture would be required to treat the seeds for one hectare.

Sowing time

Sowing of the rabi crop which is raised on residual soil moisture should be done in the month of November and the irrigated summer crop should be sown in the second fortnight of January. Sow the seeds in lines at a spacing of 25cm X 10cm for bunchy and semi-spreading types. The seed rate is 125 kg kernel/ ha. Use groundnut planter or follow dibbling behind the plough for ensuring line sowing. Ensure depth of sowing within 5 cm of the soil under sufficient moisture conditions and deeper placement at 8-10cm in light soils with insufficient surface moisture. Follow laddering for better seed-soil contact.

Fertilizers

Apply 20 kg N and 40 kg each of P_2O_5 and K_2O/ha in the furrows before sowing and mix with the soil so that seeds do not come in direct contact with fertilizer. Phosphorous should be applied in form of single super phosphate which also meets the sulphur requirement of the crop i.e. 30 kg S/ha. Apply well-powdered gypsum @ 250 kg/ha close to the base of plants at 20-25 days after sowing on either side and incorporate in the soil, so that it remains in top 3 cm of soil. This is required because calcium has to be supplied to the developing pods independently as movements of calcium from vegetative parts to the pods through gynophores is limited due to narrow xylem vessel in the gynophores. This will improve the number of pods and pod filling. Apart from 22.3% calcium, gypsum also supplies 18.6% sulphur to the soil. Sulphur deficiency is likely to develop where groundnut is taken up continuously with high analysis fertilizer like urea and DAP. However, gypsum is not required when SSP or Ammonium sulphate is used as it also supplies sulphur.

Intercultural operations

Perform hoeing and weeding within 3-4 weeks after sowing to make the crop weed free. It also helps to conserve the residual soil moisture. Subsequently remove the weeds manually wherever needed so that it will not damage the gynophores and interfere pegging. Alternatively, apply pendimethalin or metolachlor 0.75kg/ha as pre-emergence spray 1-2 days after sowing or fluchloralin 0.75 kg/ha as pre-planting incorporation one day before sowing. Post-emergence of quizalofop ethyl 5 EC @ 0.05 kg/ha at 20 days after sowing takes care of the later flush of grassy weeds under irrigated conditions.

Major weeds

Amaranthus viridis, Boerhaavia diffusa, Celosia argentena, Chloris barbata, Cynodon dactylon, Cyperus rotundus, Portulaca oleracea, Trichodesma indicum.

Weed management

Irrigated

- Pre-sowing: Fluchloralin at 2.0 l/ha soil applied and incorporated followed by light irrigation.
- Pre-emergence: Fluchloralin 2.0 l/ha or Pendimethalin @ 3.3l/ha applied on third day after sowing through flat fan nozzle with 500 l of water/ ha followed by irrigation. After 35 - 40 days one hand weeding may be given.
- Spray Imazethapyr @ 750 ml/ha at 20-30 days after sowing based on weed density as post emergence spray.
- If no herbicide is applied two hands hoeing and weeding are given on 20th and 40th day after sowing.
- Apply, PE Oxyfluorfen @ 200 g/ha on 3rd DAS followed by one hand weeding on 40-45 DAS.

- Apply, PE Oxadiazon @ 0.8 kg ha-1 followed by one earthing up using hoes (or) working star type weeder.
- Apply, PE Metalachlor @ 1.0 kg ha-1 followed by one hand weeding on 40 DAS.

Rainfed

- Pre-sowing: Fluchloralin at 2.0 l/ha soil applied and incorporated.
- Pre-emergence: Fluchloralin 2.0 l/ha applied through flat fan nozzle with 900 l of water/ha followed by irrigation. After 35 - 40 days one hand weeding may be given.
- If no herbicide is applied two hands weeding and hoeing are given on 20th and 40th day after sowing.

Irrigation

It is advisable to sow the crop with pre-sowing irrigation, or else apply one post sowing irrigation to facilitate germination. Subsequently, provide irrigation at 10-15 days interval depending upon soil and weather conditions. The critical growth stages for irrigation are flowering, pegging and pod formation. Early season stress at the vegetative stage is helpful for uniform flowering. In flat bed method of sowing, apply irrigation in cross channels made at an interval of 4-5 meter.

Plant protection

Treat the soil against termites and white grub attack.

Diseases

1. Tikka disease

Symptoms

Dark brown to almost black circular spots appear on leaves, petiole and stem. In severe cases, the spots coalesce causing defoliation of the plants.

Control measures

Before sowing treat the seed with thiram or (carboxin 37.5% + thiram 37.5%) DS @ 1.5 g/kg of kernel. Spray with ziram (0.2%) or chlorothalonil(0.25%) or Mancozeb @ 750 g or copper oxychloride @ 0.6 kg or carbendazim @150 g/acre in 200 litres of water 2-3 times at an interval of 10 days.

2. *Aspergillus* seedling blight or collar rot/foot rot/alfa rot

Symptoms

The pathogen causes rotting of the seeds in the soil, later the disease in characterised by wilting and death of seedling accompanied by a rotting of hypocotyl region and development of black lesions.

Control measures

Seed treatment with carbendazim (0.15%)+thiram (0.3%) or carbendazim @ 1.5g/kg of kernel or with thiophenate methyl (0.15%). Spray the crop with mancozeb (0.25%) or carbendazim (0.15%) or copper oxychloride (0.25%) or (mancozeb63% + carbendazim 12%) @ 0.2%.

3. Stem rot

Symptoms

Diseased plants turn yellow, necrotic and finally wilt. Diseased tissues develop yellowish brown mustard like sclerotia.

Control measures

Treat the seed with carbendazim (0.15%) + thiram (0.3%) or (carboxyn 37.5% + thiram 37.5%) DS @ 0.15%. Spraying with carbendazim (0.15%) or with thiophanate methyl (0.2%). Soil drenching around the root zone of the plants with thiophanate methyl (0.15%) is effective.

4. Rust

Symptoms

Rust appears on leaflets. The yellowish brown pustules appear on the lower leaf surface, corresponding upper surface showing yellow dots which turn brown. Leaves dry and shed prematurely.

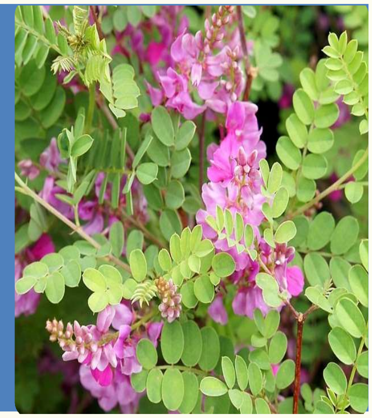
Control measures

Spray with mancozeb (0.2%), sulphur dusting @ 12kg/ac or spray with hexaconazole (0.2%).

Harvesting and Yield

When leaves of the plant become yellow and dry, Groundnut is harvested. In Kharif season it gives 6-8q/acre yield, but in Rabi, it yields about 8-10 q/acre.

Indian Indigo - A High Volume Traded Medicinal Plant



P. V. Sindhu[1], C. Beena[2] and P. Sindhumole[3]

Indigofera tinctoria L., a member of the family Leguminosae is one of the oldest coloring agents known to man. In Sanskrit, Indigo is known as Nila, a word which signifies dark blue or black. The plant was used as a dye and as medicine in the East from time immemorial. It was an important article of trade and called as *Banigbandhu*, or "trader's friend." It was probably exported from Cambay, Broach and Thana at a very early period. *Indigofera tinctoria* is native to India, one of the oldest known centres of indigo dye production. The association of India with indigo is evident from its Greek name, "indikon", meaning 'blue dye from India' or 'Indian substance'. The Romans used the term indicum, which eventually tuned into English as the word Indigo. Ved and Goraya (2007) included *Indigofera* as a medicinal plant species of high volume trade (>100 Tonnes/year) sourced largely from cultivation. In Ayurvedic system of medicine, *Indigofera tinctoria* is used as a major ingredient of "Neelibhringadi thailam", "Neeli thulasiadi thailam" and "Neeli thulasiadi kashayam". Being a leguminous crop, it improves the fertility of soil through nitrogen fixation and hence suitable for cultivating in marginal lands.

Vernacular names

English :	Indian indigo
Hindi :	Nili
Kannada :	karunili
Malayalam :	Neelamari
Sanskrit :	Nililini
Tamil :	Avuri
Telugu:	Nili Chettu, Nili

Seedling stage

Active growth stage

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Blooming stage

Fruiting stage

Distribution and habitat

The plant is distributed in South, South East Asia and tropical Africa. In India, it is found almost throughout the country and cultivated in many parts of the country.

Description of plant

Depending on the climate in which it is grown, indigo may be an annual, biennial, or perennial. It is a branching shrub growing upto 2 m height. Leaves are alternate, stipulate, imparipinnate with 7-13 leaflets. Leaves are green when fresh and grayish black on drying. Tender branches are bluish red in color. Flowers are small, many, nearly sessile, red or pink in colour. Fruits are cylindrical pods, pale greenish grey when young and dark brown on ripening with 10-12 seeds.

Traditional uses

Whole plant of Indigo is used for various commercial purposes. This is the original source of natural indigo dye. Indigo dye is obtained by processing of the leaves. Nili is a reputed drug produced from *Indigofera tinctoria*, which is used in ayurveda for the promotion of hair growth and it forms a major ingredient of preparations like neelibringadi oil. In siddha and ayurvedic treatments *Indigofera tinctoria* is used in constipation, liver disease, heart palpitation and gout.

The stems, leaves and roots are bitter, laxative, diuretic, thermogenic, trichogenous, expectorant and anthelminthic. It is used in treatment of echolalia, splenomegaly, cardiopathy, chronic bronchitis, asthma, ulcers and skin diseases. The juice extracted from the leaves is useful for the treatment of hydrophobia. Plant extract is good for epilepsy and neuropathy. The plant possesses anti-toxic property. The plant is stimulant, deobstruent and purgative. Indigo is antiseptic and astringent. The Juice of the leaves mixed with honey is effectively used against enlargement of liver and spleen, epilepsy and other nervous problems.

In hydrophobia two ounces of fresh juice with an equal quantity of milk is given in the morning for three days as prophylactic. The leaf juice is also given for treating asthma, whooping cough, palpitation of heart, in some lung diseases and kidney complaints. Decoction of the root is given in cases of calculus; Juice of the young branches mixed with honey is used in application for aphthae of the mouth in children. An infusion of root is given as an antidote in cases of arsenic poisoning. Externally, leaves crushed are used as poultice or plaster in various skin diseases and to cleanse, heal wounds and ulcers. To promote the action of bowels, it is applied by mixing with castor oil to the navel of children and mixed with warm water to the pubes and hypogastria as it stimulates bladder.

Phytochemical constituents

Phytochemical constituents of Indigo include com-

pounds like galactomannan, composed of galactose and mannose in molar ratio of 1:1.52, glycoside (Indican), coloring matter (Indigotin), flavonoids, terpinoids, alkaloids, indigotine, indiruben and other related compounds.

Soil and climate

Indigofera tinctoria requires good sunlight and grows well in plains. The crop prefers open condition for better yield and quality. However, it can perform well in areas with shade level up to 25 per cent. Sandy loam soils are best suited for cultivation. Soils with water stagnation are not suitable. It can withstand high temperature if provided with adequate irrigation.

Propagation

Crop is usually propagated by seeds. Seeds are very small and have hard seed coat. To break the dormancy, seeds are mixed with sand and ground gently. Dipping seeds in boiling water for one second can also improve germination. Seed rate is 3 kg/ha. Seeds are broadcasted by mixing with sand to ensure uniform coverage. Seeds will germinate within 15 days and seedlings will be ready for transplanting after one month.

Good Agricultural Practices

Detailed Studies for the development of "Good Agricultural Practices" for *Indigofera* were conducted at All India Co ordinate Research Project on Medicinal, Aromatic Plants and Betel vine (AICRP on MAP&B), College of Agriculture, Kerala Agricultural University. Studies on optimum date of planting showed that the best time for planting in Kerala is August - September. For cultivation, soil is brought to fine tilth by ploughing two to three times. The optimum spacing is 45 cm x 30 cm. As a source of nutrients, apply

Effect of planting dates on herbage yield of *Indigofera tinctoria*

Treatments	Herbage yield (kg/ha)
Planting dates	
2nd Week of August	5090
2nd Week of September	5073
2nd Week of October	4581
CD(0.05)	232.2

Herbage yield of *Indigofera* as influenced by spacing

Treatments	Herbage yield (kg/ha)
Spacing	
45cm X 30 cm	3939
60 cm X 30 cm	2853
60 cm X 45 cm	2671
90 cm X 60 cm	2166
CD (0.05)	286.6

farmyard manure @ 10 t/ha or vermicompost @ 3 t/ha with *Azospirillum* (2kg/ha) as basal. Incorporate manures with soil at the time of last ploughing. Weeding has to be done twice, first at three weeks after sowing and second at six weeks after sowing. During dry periods frequent irrigation is required.

Effect of combination of organic manures on herbage yield of *Indigofera tinctoria*

Treatment	Total herbage yield (kg/ha)
FYM (10t/ha)	4485
FYM (10t/ha) + *Azospirillum* (2kg/ha)	5450
FYM (10t/ha)+ *Azospirillum* (2kg/ha)+ VAM (2kg/ha)	4641
Vermicompost (3t/ha)	4371
Vermicompost (3t/ha)+ *Azospirillum* (2kg/ha)	5209
Vermicompost (3t/ha) + *Azospirillum* (2kg/ha) + VAM (2kg/ha)	4630
Coirpith compost (4t/ha)	4054
Coirpith compost (4t/ha) + *Azospirillum* (2kg/ha)	4116
Coirpith compost (4t/ha)+ *Azospirillum* (2kg/ha)+VAM (2kg/ha)	2752
CD(0.05)	389.8

Harvesting

Plants start flowering 3 - 4 months after sowing. Harvesting is done by cutting the plants at this time, at a height of about 15 -20 cm from ground level. Irrigate plants immediately after harvest. Liquid organic manures such as fresh cowdung slurry can be applied

Continued on page 24

Grape Rootstocks for Sustainable Production

Dr. S. K. Verma and Dr. M.K.Rai*

Commercial exploitation of rootstocks till now in grapes was not known in India since grapes were exclusively grown on their own roots. The decline in yield due to the problems associated with soil and water salinity, chlorides in irrigation water, excess levels of sodium and free lime in soil as well as abiotic and biotic stresses have altered the situation. Even though the horticultural practices viz., mulching, green manuring, leaching of salts, use of soils amendment and pesticidal spray to contain these problems have been employed by the growers but a little success has been achieved by these methods. Under such conditions, the use of rootstocks to sustain the productivity of grapes under adverse situations seems to be promising as many rootstocks in grape have been identified, which are capable of mitigating these problems. The rootstocks having tolerance against various adverse conditions and suitable for cultivation in such conditions are mentioned here:

1. Salinity tolerance: Soil salinity is one of the major problems posing threats to viticulture industry in Punjab, Haryana and Maharashtra. Salinity problem is increasing in the command areas of irrigation projects in India year by year. Therefore, rootstocks resistant to soil salinity are of paramount importance in viticulture.

In saline soils, saline injury leads to marginal leaf burning, premature leaf fall, stunted and weak growth. Cultivation on rootstock is recommended where EC (Cations Exchange) of saturation extract is more than 4 mmhos/cm, ESP (Exchangeable sodium percentage) is less than 15 and pH is less than 8.5. The rootstocks used in saline soil are Ramsay, Solonis, 1616, 1613, 99-R, St. George, H-324, Dog ridge and Degrasset.

2. Calcareous soil tolerance: Calcareous soil poses challenge for cultivation of grapes, especially in areas having excess amount of lime (CaCO-$_3$) at some horizons of the soil profile (Zonal soil of arid regions). Calcareous soil injury leads to stunted root growth which reduces absorption of nutrients resulting in plant death. The rootstocks recommended in calcareous soil are 99-R, 110-R and 150-15.

3. Drought tolerance: In the areas like semi-arid tropics where evapotranspiration is high, grapevine suffers from soil moisture stress resulting in weak growth and poor crop production. Deficit moisture leads to reduced berry size with dull fruit colour. Rootstocks provide vigour root system to the scion, which are capable in developing the feeder roots and also reach further from stem. The rootstocks suitable for drought tolerance are: 110 Richter, 140 Ruggeri, 1103 Paulsen, SO4 and 99 Richter.

4. Winter hardiness: Some rootstocks impart resistance to scion cultivars for cold tolerance. The rootstocks are: Teleki 5 C, 99 Richter and 3309 C and the Cold hardy species are: *Vitis riparia, V. amurensis and V. cordifolia.*

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5. Nematode resistant: In India, nematode problem has been found to be more prevalent in light soil. Nematode causes damage to grapevines by damaging the root system and acts as vector for transmitting soil born viruses. The rootstocks resistant to nematodes are: Dogridge, Salt Creek, 1613, 1616 and Teleki - 5A.

6. *Phylloxera* resistant rootstocks: The best and highly productive use of rootstocks in grapes is against *phylloxera* infestation. *Phylloxera* is an aphid infesting the roots of grapevine. These insects destroy more than 75 per cent of the areas under grape. The rootstocks resistance to phylloxera are: Riparia, St. George, 1202, 99-R, A x R1, 3306, 3309 and SO4.

Rootstocks not only combat the adverse situation but affect on vigour, maturity, yield and quality also.The effect of rootstocks on growth and development of grapevine is as under:

1. Size and growth habit: The effect of rootstock on size and growth of scion cultivars is important. The impact of rootstocks on growth habit of the scion cultivars is tabulated as under:

Influence of rootstocks on vigour:

Rootstocks	Vigour
Dogridge, Salt Creek (Ramsay) St.George, Kober 125 AA and 140 Ru	Very vigorous
Harmony, 1613, Freedom, S04 and 5BB Kober	Vigorous
Riparia Gloire, 3309 Coudrec, 101-14, Millerdet et de Grasset, 161-49 Coudrec and Teleki 8B	Semi vigorous
US17 and US41	Dwarf

2. Fruiting and maturity: Rootstocks not only influence vegetative growth and vigour of the plant but also the fruit setting and maturity of fruit scion cultivars.

3. Rootstocks for improvement in yield and quality: Rootstock is considered important to manipulate shoot vigour and to bring equilibrium between growth and yield. In India, effects of different

Grafted Rootstock in Pot

Effect of rootstocks on fruit setting and maturity:

Rootstocks	Fruit setting	Maturity
Riparia Gloire	Improved	Improved
St. George	Delayed	Delayed
3309 Coudrec	Improved	Improved
101-14	Improved	Improved
S04	Delayed	Delayed
Teleki 8B	Improved	Improved
Teleki 8C	Delayed	Improved
420 A	Improved	Delayed
99 Richter	Improved	Delayed
Kober 5BB	Irregular	Delayed
110 Richter	Irregular	Delayed
1103 Paulsen	Delayed	Delayed
1616	Improved	Improved

Field View of Grafted Rootstock

rootstocks on yield and quality of different scion have been investigated.

4. Rootstocks for increased nutrient efficiency: Rootstocks are the active sites of absorption of nutrients. Root cation exchange capacity is basically responsible for nutrient absorption. Grapevine rootstocks differ in their capacity to exchange cation and thereby vary in their capacity to absorb nutrients and exclude toxic ions. Resistance to salt and chloride is the best example of such phenomenon.

Information on the preferential absorption of different plant nutrients by different rootstocks is helpful in identifying the rootstocks for specific situations and use of rootstocks in economic application of fertilizers.

Yield of scion cultivars

Rootstocks	Yield kg/vine
41B	6.3
1103P	2.8
Banglore Blue	8.5
Dog ridge	12.5
161-49	14.2
Kober 5BB	13.0

Grafted Rootstock in Pot

Effect of rootstocks on quality:

Rootstocks	T.S.S. (Brix)
99 R	18.2
101-14	20.2
1103 P	19.9
S04	20.0
Kober 5 BB	23.5

Nutrient uptake of scion cultivars as influenced by rootstocks:

Rootstocks	Remarks
Dogridge	Increase petiole nitrogen content
Ramsay	Increase the total nitrogen and potassium contents
34 EM	
41 B	Increase from content in the leaves
3309 C	Induce potassium deficiency
R 110	Increase Ca and iron content

Continued from page 21

after every harvest. Subsequent harvests can be made at 1.5 - 2 months interval. Four to five cuttings can be taken in a year depending on the growth.

Seed collection

A few plants per plot can be left without cutting to set seeds. Ripe pods are to be harvested in the early morning to prevent loss of seeds by shattering during harvest. Seeds thus collected can be used for raising nurseries for next crop.

Post Harvest Management of Mushrooms

Sudha Nandni, Devanshu Dev, Biswarup Pati, Saibal Ray and Dayaram

Mushrooms are best eaten fresh, however, availability of fresh mushrooms is limited and consumption of fresh mushrooms is not practical for large population. When compared to other horticultural crops, harvested mushrooms have a high rate of respiration, resulting in a shorter post-harvest life.The mushroom production could be done round the year under controlled environment units. Although, seasonal growers start cultivation during the winters when supply at the local market exceeds demand, resulting in low profit due to price decrease and spoilage as the market is flooded with stocks of produce.

Mushrooms are perishable items which swiftly deteriorate due to browning, wilting, liquefaction, texture, scent and flavour loss is among other factors, rendering them unmarketable. Because most mushrooms are saturated with moisture and have a tender texture, they cannot be kept for longer than 24 hours in the tropics' higher temperatures.

To extend the shelf life of fresh mushrooms, proper postharvest methodologies have been developed. In terms of processing technology, conventional drying of mushrooms under the sun is one of the oldest and simplest techniques used by mushroom farmers since the ancient period. Now a days, innovative preservation procedures such as canning, pickling, mechanical and chemical drying (freeze drying, batch type cabinet drying, fluidized bed drying and osmotic drying) and irradiation treatment have been developed to extend the shelf life and consumption of mushrooms.

The mushroom market in India is a result of the contributions of small and marginal farmers with scarce resources who depend on public markets to sell their stuff. Quality produce is a pre-requisite for obtaining most of the benefits from marketed produce. Hence, following post harvest management practices may be adopted for fetching higher price of marketed mushrooms:

1. Washing: The whiteness of mushrooms is enhanced by washing them in 0.05 percent potassium meta-bisulphite, which lasted longer during storage. Although many farmers are selling cleaned and unwashed mushrooms with proper packaging, because many people prefer to eat mushroom not just for its health benefits, but also because it is a chemical free meal.

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2. Modified atmosphere packaging (MAP): Mushrooms' storage life can be extended by covering them with Polyvinyl chloride film. In refrigerated conditions, 100 gauge transparent plastic bags with 0.5 percent ventilation space are advised for packing mushrooms. Instead of utilising polythene bags to ship mushrooms across long distances, polystyrene or pulp-board punnets should be utilised. Differentially permeable PVC or poly acetate films are used to encase the punnets. They produce a modified atmosphere in punnets that consists about 10 per cent carbon dioxide and 2 percent Molecular oxygen which is close to the optimum atmosphere conditions for storage of mushrooms.

The antifogging film outperformed the other packaging materials, such as anti-fogging oriented nylon, polyvinylidene chloride coated vacuum packing film or wrap used in preserving the quality of the mushrooms for 3 weeks. Under modified humidity packaging settings, the optimum packing material, polyethylene, improves the shelf life of fresh mushrooms up to 2 weeks. Potassium permanganate, chitosan, activated carbon and sorbitol are some of the additional packaging materials that may be used in modified humidity packaging to keep oyster mushrooms fresh at room temperature.

In button mushroom, washing in chlorinated water and using dehumidifiers reduced microbe induced spoilage and extended storage life. When packed and kept in the fresh mushroom trays overwrapped with Polyvinyl chloride films, sorbitol preserves the optimum colour in the mushroom.

3. Modified humidity packaging: There are two approaches to attain the intended IPRH (In Package Relative Humidity): The use of in-package moisture absorbing compounds like calcium chloride, which can retain the required relative humidity, and perforation of the package, which eliminates the chances of reaching modified atmospheric conditions inside that package. Modified atmospheric packaging in combination with modified humidity packaging improved the storage life of fresh mushrooms even further. For the optimum colour in mushrooms during storage, an IPRH of 87-90 per cent is recommended.

4. Controlled atmospheric storage (CAS): It extends the shelf life and decreases brown discoloration (enzyme - mediated browning). The use of calcium chloride in the irrigation water optimizes the canned mushroom colour. Mushrooms exposed to lower airflow rates in the growth chamber remain whiter than those exposed to higher airflow rates. Pre-harvest watering applications of a patented type of stabilised chlorine dioxide (oxine, 200 ppm) on mushrooms resulted in a decreased incidence of blotch and whiter mushrooms throughout the storage term. To enhanced shelf life of packaged mushrooms, commercially available moisture absorbers like montmorillonite clay and silica gel can be used.

5. Packaging: Mushrooms are packaged for local markets in India in commercial packages of 200 g or 400 g in less than 100 gauge thick basic polythene bags. Mushrooms are packaged in massive amounts in polythene or pulp-board cartons that may resist long-distance shipping. Differentially permeable Polyvinyl chloride or polyacetate films can be used to cover these punnets. This overwrapping aids in the creation of a modified environment in cartons with 10 percent carbon dioxide and 2 percent molecular oxygen, allowing mushrooms to retain their original appearance for 72 hours at 18 °C. To extend the storage life of mushrooms Controlled Atmosphere Packaging (CAP) and Modified Atmosphere Packaging (MAP) methods must be employed efficiently. If basic polythene bags are to be used, the required number of holes must be made for adequate humidity control.

6. Refrigeration: During storage, the temperature rises steadily owing to respiration, since the respiratory rate rises in tandem with the storage temperature. The quality of product degrades as a result of the heat. Therefore, the temperature of the mushrooms should be immediately decreased to 4-5° C. Hydrocooling, evaporative cooling, vacuum cooling, forced-chill air and ice bank systems can all be used to chill mushrooms to a temperature of 2-4°C.

Problems arise when packs include more than 10 kg of mushrooms or layers of mushrooms that are 15 cm thick. Cooling is more effective when air flows vertically. To avoid discoloration, mushrooms should not be kept in the same cooler as fruits, which produce volatile chemicals and gases like ethylene. This inefficient forced-chill air-cooling technology is being phased out in favour of vacuum cooling.

7.Vacuum Cooling: Evaporative cooling can drop the temperature from ambient to 2°C in 15 to 20 minutes. Vacuum cooling is a faster and more consistent technique in which mushrooms are subjected to reduce pressure and water evaporates, releasing the latent heat of vaporisation.The colour and appearance of vacuum-cooled mushrooms is better than that of ordinarily chilled mushrooms. The system's disadvantages include a large initial investment and an unavoidable loss of fresh weight. Mushrooms may also be quickly cooled using air spray humidifying chillers. Without losing any moisture, the temperature may be decreased by 16-18° C in an hour.

8. Ice-Bank Cooling: In some regions, ice bank cooling of mushrooms is currently used, in which a mound of mushrooms is propelled through an ice bank using a forced blow of cold, humidified air to reduce weight loss during vacuum chilling.

9. Steeping Preservation: Water blanched mushrooms are soaked overnight in 1 per cent Potassium Meta-bisulphite Solution (KMS) and 2 per cent citric acid before drying, which enhances colour, texture, and reconstitution characteristics. A solution comprising 2 per cent sodium chloride, 2 per cent citric acid, 2 per cent sodium bicarbonate and 0.15 percent KMS is used for steeping preservation of blanched mushrooms for 8-10 days at 21-28ºC. Mushrooms can also be preserved by steeping them in a chemical solution comprising, 2 per cent salt, 2 per cent sugar, 0.3 percent citric acid, 1 per cent ascorbic acid and 0.1 percent KMS. It assists in the long-term storage of mushrooms.

10. Canning: Washing of mushrooms in iron-free water with 0.1 percent citric acid is used to avoid discoloration. After that, blanching is frequently done to inhibit polyphenol oxidase enzymes activity and kill microorganisms. It also reduces bacterial populations and removes gases from mushroom tissue. The mushrooms are blanched in a boiling solution of 0.1 percent citric acid and 1 per cent common salt in stainless steel kettles. The blanching time at 95-100°C is between 5 and 6 minutes.

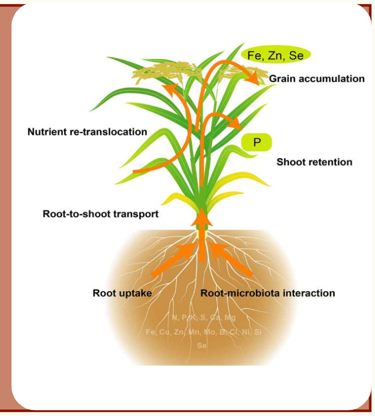
After blanching the mushrooms, they're packed into sterilised tin cans. After increasing the temperature of the mushroom-filled cans to 90°C, a brine solution (2 per cent salt mixed with 0.1 percent citric acid or 100 ppm ascorbic acid) is added. After filling, the cans are exhausted by passing them through an exhaust box for 10-15 minutes, or until the temperature in the centre reaches 85°C.The cans are then tightly sealed with a double seamer and stored upside down. After the cans have been used up, they must be sterilised. Sterilization of the cans to 118°C is performed in order to prevent bacteria from degrading them during storage. To avoid overcooking and stack burning, the cans were quickly chilled following the sterilizing procedure. Putting the cans in a chilled water tank will allow them to cool.

11. Radiation Preservation: Low level of gamma radiation can be used to reduce contamination and extend the shelf life of mushrooms. For best results, irradiation should be applied just after harvest. Radiation exposure can potentially delay maturation, such as the growth of the pileus, stipe, gills and spores, as well as diminish water loss, aroma, texture, and quality losses. Microorganisms are totally killed by a dosage of 10 KGy (Kilo Gray). The plant's storage life can be increased up to 10 days by employing gamma rays near 2 KGy and storing button mushrooms at 10°C.

The incidence of fungal and bacterial infection is lowered by irradiation. Irradiated mushrooms exhibit a loss of flavour components. Irradiation also delays the opening of the pileus. Gamma irradiation preserves amino acids in fresh mushrooms. Low-level irradiation performed better than 1 and 2 KGy irradiation. In our country, the allowed dosages for such preservation have yet to be determined.

12. Transport: Mushrooms must be transported in a chilled environment. Mushroom polypacks can be placed in small wooden cases or boxes with enough crushed ice to keep the mushrooms cold for short distance transport (over-wrapped in paper).Transporting huge quantities in refrigerated vehicles across long distances is more expensive.

Improvement of Nutrient Use Efficiency in Agriculture



Rajan Bhatt

Improving Nutrient Use Efficiency (NUE) in the field crops is one of the important topics in current scenario, particularly under declining natural resources *viz*. land as well as water and burgeoning population. For harvesting higher yields, farmers intend to use higher amounts of fertilizers, particularly nitrogenous, which instead of improving yields, invite higher incidence of insect pests and diseases, pollutes underground water and causes global warming which itself has several adverse consequences. There are some approaches for the field crops, whereby the efficiency of applied nutrients could be enhanced sustainably which not only reduces the insect-pest and disease attacks or mitigate the adverse effects of global warming or improve the yields but finally reduces the cost of cultivation and hence improves the livelihoods of farmers. The limitation of these approaches is that they are not universally applicable and are both site and situation-specific.

Further, it is revealed that around, 70, 20, 10, and 20% of soils reported being deficient in N, P, K and S respectively, followed by 21, 12, 12, and 2% soils deficient in Zn, Mn, Fe, and Cu respectively, due to intensive cropping sequences adopted in the region. In addition to this, underground water showed a sharp decline along with deteriorated quality due to flood irrigation coupled with excessive use of inorganic fertilizers. The government also imposes laws *viz*. "Subsoil water preservation act-2009" or "Paddy transplantation law not before 10th June" for the judicious use of underground water. Hence, Punjab's natural resources were exploited a lot during the era of the green revolution both in terms of soil and water. Restoration of these natural resources is urgently required in a sustainable manner.

Hence, to practice sustainable agriculture in the region, the scientists of Punjab Agricultural University, Ludhiana developed, tested and disseminated technologies for improving nutrient use efficiency, land and water productivity along with soil health. Following is a brief of these technologies for improving nutrient use efficiency in field crops:

1. In favor of supplementing nitrogen (N) requirement of the crop, urea is the superior source which should be applied in the splits while phosphorus and potash (immobile nutrients) should be drilled close to the seed.
2. Phosphorus should be applied only to the rabi crops *viz*. wheat.
3. The phosphorus requirement of the groundnut should preferably be met through single super phosphate.
4. Slow N release fertilizers *viz*. Neem-coated urea should be used to improve fertilizer use efficiency.
5. Real-time and need-based application of N fertilizer to the crop improves NUE along with decreased fertilizer use. Leaf Colour Chart (LCC) is a farmer-friendly gadget that guides the farmers in this direction.

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6. Organics *viz.* farmyard manure, green manures (*Sesbania* and sunhemp) improved crop yields in cereals *viz.* rice, wheat, maize and sugarcane which further saved about 40-60 kg N ha^{-1}.

7. Poultry manure @ 5 t ha^{-1} compensate for 80 kg N ha^{-1} in rice, 30 kg N and 60 kg P_2O_5 in the following wheat.

8. Agro-industrial wastes *viz.* rice husk ash and bagasse ash @ 10 t ha^{-1} improved the overall land productivity in the rice-wheat cropping sequence.

9. Grain yield of maize could be increased by 5-10 q ha^{-1} by incorporating residues of pea within the field before maize sowing.

10. Phosphorus (P) application to soybean after wheat should be reduced to $1/4^{th}$.

11. Sulfated- P fertilizer material can be used in case of non-availability of the phosphorus or sulfur fertilizers.

12. In Zn deficient soils, application of $ZnSO_4$ @ 62.5 kg ha^{-1} at transplanting of paddy or sowing of maize, cotton helps in treatment of Zn deficiency. Further, in the later stages, 0.5% foliar application of $ZnSO_4$ solution also helped in correcting the deficiency.

13. Always apply fertilizers as per the soil test reports, depending upon the inherent fertility of the soil as the crop is to be fed but not the soil.

14. Apply 0.3% $ZnSO_4$ to citrus plants without lime addition to spring flush in April-May, to summer flush in June, and late summer flush in August-September.

15. Apply 0.5% of foliar application of $MnSO_4$ in case of manganese deficiency in wheat. Apply 3-4 times on sunny days at weekly intervals initiated 2-3 days before 1^{st} irrigation.

16. In crops, *viz.* sugarcane and paddy, iron deficiency in coarse-textured sandy soils can be corrected by applying 3 foliar sprays of 1% $FeSO_4$.

17. Pond water can be used as an additional source of water as well as nutrients. The same could be used under site-specific conditions with canal or tube well water.

18. Integrated nutrient management *viz.* proper use of chemical fertilizers along with organic inputs *viz.* farmyard manure, press-mud, compost, poultry manures has been found to be the best strategy for practicing climate-smart agriculture.

19. Biofertilizers also help to enhance the availability of inherent nutrients in the soil which might already be fixed for meeting the requirements of plants and reduces the demand for fresh fertilization.

With the help of these technologies, farmers of the region could manage to improve the fertilizer use and hence, nutrient use efficiency without cutting off any yields from their fields. These technologies also help in cutting down the fertilizers quantum which on one side mitigates the adverse effects of the global warming and underground water pollution and on the other side helps to reduce the overall cost of cultivation. This overall set of practices improve the livelihood of farmers as well as their income.

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Management Strategies for Increasing Milk Production in Dairy Cattle

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Management plays key role in increasing milk production of dairy cattles and has a direct impact on the amount of milk produced. All the inputs for dairy animals are made with the ultimate aim of obtaining milk. Milk is also the source of income. Management strategies will take various factors into account such as housing management, feeding management, reproductive management, milking management and health management. These are described below which will help the dairy farmers for better management of lactating animals.

Housing management

Proper housing is conducive for good health, comfort and protects from inclement weather as well as enables the animals to utilize their genetic ability and feed for optimal production. Shelter facilities in hot and humid condition, feeding facilities round the clock especially at night in summer, water supply for drinking during hot weather and flow of fresh air should be insured for well being of dairy cattles.

Improving the Existing Sheds

Improvement in existing cattle sheds can provide more comfort to animals and result in clean milk production. The changes should be made gradually that too by using cost effective, locally available material. Some of the alterations for improving the existing cattle sheds are as under:

- The cattle sheds may have a roof made of straw and mud which may be leaky during rains. Such roof harbors insects and pests in rainy season. It is advised to replace such roof with better material.
- The floor of the shed should be made even by leveling off ridges and filling up of pits. The surface can be paved with concrete and bricks.
- Traditional cattle sheds are very close to or in between living quarters and height of walls in the shed is very low. This results in dark and poorly ventilated sheds. Over-crowding of cattles is another problem in traditional sheds. Farmers should insure that there is about 40 square feet of area per cow and 45 square feet per buffalo in their cattle shed. This makes the animals more comfortable and better production is obtained.

Feeding management

Feeding is an important aspect of dairying as it accounts for around 70% of total cost of milk production. It should be cost effective and palatable to the animals. Cattle feed contains carbohydrates, proteins, minerals and vitamins required for the growth, development and milk production of animals. Cattle should be fed well-balanced feed as a prerequisite for optimal milk production and reproductive efficiency. It should meet the energy and protein requirements of cattle for milk production, growth and reproduction. The following feeding management practices may be adopted:

- Feeding of green fodder throughout the year and silage during scarcity of green fodder
- Animals fed only dry fodder should be provided urea molasses mineral block as supplement to diet depending upon its availability
- Fodder must be chaffed before feeding to avoid wastage and enhancing digestibility
- Grazing in green pastures or grass lands in the

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early morning and late afternoon hours.

- Changing from one feed to another should not be sudden but in a gradual manner
- Minerals are necessary for all metabolic function of body so, animals ration should be supplemented with area specific mineral mixture
- For body maintenance and higher efficiency of milk production compound cattle feed or by pass protein should be given
- Feeding time should not be changed frequently, feeding 2-3 hours before milking is ideal

Reproductive management

Reproduction of cattles is important considering the economics of cattle production. In absence of regular breeding and calving at the appropriate time, cattle rearing will not be profitable. Poor reproductive performance increases the calving to calving interval and therefore the average length of lactation. As a direct effect, low reproductive performance can prevent the diet from being fully utilized. Reproductive performance in dairy cattle can be improved by the following:

- Properly identifying and managing animals to carry out reproductive program
- Keeping records that enable determination of important herd indices such as percent calf crop, pregnancy rate, length of calving season, breeding efficiency of bulls and performance and production information
- Meeting the nutritional requirements of various classes of livestock in the herd, emphasizing nutritional needs and cost efficiencies
- Establishing a breeding program for heifer replacements and cows
- Practicing sire selection and reproductive management
- Adopting a vaccination or immunization program for the cow and calves
- Evaluating reproductive failure and abortions

Reducing calving interval

In dairy practice, the most common calving interval is around one year. There may be an economic advantage in having the flush of milk production, associated with calving. The reducing calving interval dimensions are discussed under the following sub-headings:

1. Start with a good nutrition program

Nutrient requirements of cattle are at their peak around breeding time. Not only is she trying to maintain her own body condition while in peak lactation to provide nourishment to a rapidly growing calf, but she is also trying to heal her own reproductive tract to support and maintain a new pregnancy. The farmer should ensure that the cattle is getting required amounts of vitamins, minerals, energy and protein needed to support adequate performance.

2. Maintain bull reproductive sounds

Bulls must be examined for breeding soundness exam (BSE), 30-60 days before turnout and their semen should be tested. If they are not fertile, the farmer will not only have a lot of open cows, but also the calving interval would become longer when all the females come into heat again for a second or third time before the farmer realizes the problem.

Milking management

The structure of the udder, teats, milking behavior and the factors associated with the milker collectively influence the efficiency of milk harvesting from the udder. Besides, method of milking, frequency of milking, stage of lactation, incomplete milking, feeding methods and nutritional status, season of calving and climate, feeding and milking time, weaning, udder stimulation and disease or use of drugs are among other factors which influence the milk production.

Monitoring of health

- All milch animals should be regularly inspected and proper health records should be maintained.
- Proper recording of body conditions score or body weight helps in monitoring the health and feeding of lactating animals.
- Milk production is severely affected by diseases which are commonly encountered in dairy herds. These diseases can reduce the efficiency of digestion (ketosis, acidosis, fatty liver, alkalosis) and cause disorders in eating behaviors (acidosis, lameness) as well as affect secretory tissues (mastitis).
- Monitoring of reproductive status (heat detection, calving interval, abnormal calving, retained placenta, abnormal vaginal discharge etc.) should be properly done.

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