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A CASE STUDY ON SPRINKLER IRRIGATION IN TUBEROSE

Karthick Vikram P, Regis Anton Roy J and John Richard J

Tamilnadu Agricultural University
Agricultural College and Research Institute, Madurai,
Tamilnadu - (625104), India
Corresponding email: karthickvikram555@gmail.com

Abstract
Tuberose is a popular cut flower, not only for use in arrangements, but also for the individual florets that provide fragrance to bouquets and boutonnieres. This flower becomes the highly profitable and tremendously yielding flower crop to the farmers under sprinkler method of irrigation. This paper attempts to prove that the study conducted to assess the efficiency of sprinkler irrigation in tuberose crop is successful in increasing the yield of the crop.

Keywords: bulbs, mealybug, sprinkler, tuberose, yield

Introduction

Tuberose (*Polianthes tuberosa* L.) is an important flower and fragrant crop that belongs to the subfamily Agavoideae of the Amaryllidaceae family. The word Tuberose is given from the latin word “tuberosa” or through French “tubereuse”, meaning swollen or tuberous in reference to its root system. This is one of the most important bulbous flowering plants that is being cultivated mainly for the production of flowers with long lasting spikes. These aesthetic flowers are the native of Mexico. Tuberose is an important commercial cut as well as loose flower that is being valued for its attractiveness and elegant appearance as well as its economical yield. Tuberose blooms throughout the year and its clustered spikes are rich in fragrance; florets are star shaped, waxy and loosely arranged on spike that can reach up to 30 to 45 cm in length. The flower is very popular for its strong fragrance and its essential oil is important component of high- grade perfumes. ‘Single’ varieties are more fragrant than ‘Double’ type and contain 0.08 to 0.14 percent concrete, which is used in high-grade perfumes. There is high demand for tuberose concrete and absolute in international markets, which fetch a very good price. Flowers of the Single type (single row of perianth) are commonly used for extraction of essential oil, loose flowers, making garland etc., while that of Double varieties (more than two rows of perianth) are used as cut flowers, garden display and interior decoration. Based on this flower crop, a study was conducted in Vilampatti village that is located in Nilakkottai block of Dindigul district.

Materials and Methods

Irrigation becomes an important aspect in crop production while raising crops. In order to assess the efficiency and importance of sprinkler irrigation in the flower crop tuberose, a study was conducted in the village Vilampatti of the block Nilakkottai that comes under the district Dindigul in February 2022. The farmer’s name is Mr. Karuthapandi and he owns nearly 2 acres of land completely under the crop Tuberose. Initially, he had cultivated traditional variety due to its unsuitability in the field he had shifted to the hybrid variety ***PRAJWAL***. Under conventional method of irrigation he had observed the incidence of major pest ***MEALY BUG***. Hence, under the guidance of agriculture officers he had installed sprinklers in his field. Nearly, 200 sprinklers are

needed for covering an acre of land. The spacing between two sprinklers is kept 6 ft so that the sprinkler covers 12ft radius from its locus. This sprinkler irrigation is the main important aspect of the study. The cultivation practices of this crop tuberose were explained in a detailed manner by the farmer. The soil type is black soil and it starts with Land Preparation by ploughing three times followed by forming Ridges and Furrows. Then the Bulbs are planted at the rate of 100 per acre with interspacing of 1 ft and interplant spacing of ½ ft. The irrigation is done using sprinklers and fertilization is done with complex fertilisers. Finally periodic harvesting is done at early morning every day. The sprinkler irrigation is very beneficial to his field in various aspects. These aspects were studied in detail. The total expenditure for establishing sprinklers in an acre of land comes around about Rs.40,000. Another nearby tuberose field owned by Mr. Periyakaruppu that was conventionally irrigated was observed. This experimental study was conducted with the main objective of analysing the sprinkler irrigation and its importance especially in tuberose crop.

Cost economics

Table.1 Comparison of Cost of Cultivation of sprinkler irrigation along with conventional.

Sprinkler Irrigation By Mr. Karuthapandi	**Conventional Irrigation By Mr. Periyakaruppu**
Land preparation – ploughing = Rs.2250	Land preparation – ploughing = Rs.7058
Planting material cost = Rs.1800 (600 bulbs)	Planting material cost = Rs.17441
Irrigation structure making = Rs.1200 (Sprinkler establishment cost = Rs.40,000 per acre (Fixed Cost))	Irrigation using tube well = Rs.9050
Weeding = 4 times =Rs.5000	Weeding using weedicide = Rs.593
Fertilizer application = Rs.4500	Fertilization = Rs.13856
Total cost of cultivation = Rs.14750	**Total cost of cultivation = Rs.47998**

It is inferred from the above table.1 that using sprinkler irrigation is one of the most profitable method for fetching higher income. The requirement of all the agri-inputs are low when compared to conventional irrigation. In conventional irrigation due to the failure of the crop by pest attack, the requirement of these inputs becomes increased and hence the cost of cultivation also gets increased as a whole.

Results and Discussion

From the experiment conducted by comparing the sprinkler irrigation along with conventional irrigation in the village Vilampatti the forthcoming points were inferred. First of all, the micro irrigation system in tuberose crop creates the most favourable micro environment. Even though the cost expenditure for conventional irrigation method is lower than that of sprinklers, a visual observation of major pest MEALY BUG infestation was predominant in the field. On the contradictory side, the presence of pest was nearly zero percent which was clearly evident in the field of Mr. Karuthapandi. The infestation was beyond the ***Economic Threshold Level*** (ETL) in the conventionally irrigated field. The crop normally fetches a yield of 25 to 35 kg per day, but this is severely getting attacked when mealy bugs infest this crop. The crop fetched a remarkable income when micro irrigation systems are installed in the field. The price of tuberose goes around Rs.100

– Rs.250 per kg during sprinkler irrigation. The income comes around about Rs.6000 per day as the average harvest comes around about 25 to 35 kg per day. A detailed survey was conducted by us in order to assess the opinion about this type of irrigation system. Nearly 70% of the farmers responded positively regarding this system. Finally, it is inferred that for this crop sprinkler is the most preferred method of irrigation.

Conclusion

The economic performance of tuberose cultivation in selected areas of Vilampatti has been evaluated in this study. The results reveal that tuberose cultivation is highly profitable at farm level. Its cultivation is also profitable compared to its competitive crops banana and papaya. Human labour, seedling, and irrigation had positive effect on the yield of tuberose cultivation. This crop is more profitable only when sprinkler method of irrigation is used. So, awareness is needed among the farmers regarding this technology to earn more income.

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A STUDY OF RADIOISOTOPES IN SOIL AND PLANT SYSTEM

Drishty Katiyar[1] and Kushal Sachan[1]
[1]Ph.D. Research Scholar (Soil Sc. & Ag. Chem.)
Chandra Shekar Azad University of Agriculture and Technology
Kanpur (U.P.) Pin-208002, India.

Abstract
There are almost 300 nuclei in nature, made up of different elements and their isotopes. Soil provides most of the essential elements expected for plant growth and development. Isotopes are nuclei with the same number of protons but different number of neutrons. Radioactivity proves to be very advantageous in various area specialization of daily adopt such as medicine, agriculture and industry. Radioisotopes can be used in a variety of agricultural systems. In agriculture, radioisotopes are used in nutritional analysis of major and minor elements, mechanism of photosynthetic studies, and uptake of nutrients and ion mobility in soil. Assessing the accessible soil nutrient is crucial in generating optimal fertilizer use. Radioisotopes are introduced into the environment after accidents in nuclear power plants or nuclear weapons tests. The immobility of these radioactive elements in the topsoil poses a difficulty for human health because they can conveniently enter the food chain. Preventing their assimilation by plants can be a first stage in completely re- establish contaminated areas. The radio labelled fertilizer was applied to study fertilizer uptake, utilization and retention. Applications of radioisotopes and radiation assistance us to find the solution to difficulties in a much shorter time. The creation of radioisotopes by nuclear reactors and other nuclear facilities has increased the application of radioisotopes in agriculture. Scientists solve the mysteries of numerous agricultural problems that could not have been imagined in a formal way. This article specifically addresses the application of radioisotopes and radiation in the soil plant system.

Keywords : Radioisotopes, Nuclei, Agriculture, Application, Nuclear, System.

Introduction

Radioisotopes plays an essential purpose in improving and upgrading agricultural science. Radioisotopes are adopted as an investigation tool to expand latest strains of agricultural crops that are more disease resistant, of higher quality, enable before time maturation, and producing higher yields. When arthropods are sterilized or disinfect with radiation, they mate without progenerating off-springs, thus offering some dominance, over insect generations growth. With some pests, agricultural crops can flourish. Radioisotope tracers in the nutrient of plants permit scientists to create discoveries that have heighten the efficacy of fertilizers. An essential determinant for successful and auspicious crop production is the existence of a sufficient water supply. Nuclear moisture density meters can monitor soil moisture levels and assistance make the highly effective utilization of limited water sources. Higher plants are primarily autotrophic and attain radiant energy from their environment. They only require ions of inorganic compounds and the simple molecules CO2 and H20, although some can use N2 symbiotically. The inorganic ions are commonly obtained from the soil through roots. Plant nutrition, frequently chew over, cope-with ion absorption and utilization by plants. Soil science, in certain its fertility aspects, and agronomy cope-with the provision of plant roots with ions. Isotopic tracers can be adopted

providentially to act in accordance with the comportment of each and every element in soil, its transferral to plants, and its transport or convey and ensuing purpose in plants. World leading producer of radioisotopes is our country India. The fabrication of radioisotopes in the country had initialised with the authorizing of the first investigation reactor called APSARA (Swimming Pool Type 1 MW (th) Power) in 1956. Radioisotopes are applied to regulate the role of fertilizers in multiple plants. The tracer procedure is utilized to study the direction and speed of motion of an element in a plant. To do this state of affairs, into the ground near the plant, a radioisotope of this element is injected. Several days later, the plant is set systematically on pictographic paper to devise an autoradiograph. The dark portion in the X-ray image illustrate the positions attained by the element. This procedure come up with priceless knowledge adjudging the optimal season for poisoning weeds and fertilizing crops. The application of 15 N in organic fertilizer research has considerably extensive the further understanding N release from organic materials. Examining on green manure or crop residues are moderately simple. These techniques have been particularly valuable in dictating how mineralization values are affected by residue quality parameters. Earlier uses of P isotope approaches in soil fertility information have been stated ***(Fried 1964; Menzel and Smith 1984).*** Because of the attentiveness that has been concentrated on assessments of nutrient cycling and management in new and upcoming years, a multitude of new P isotope techniques have been evolved. The objective of this study is to merge the most significant isotope techniques and to methodically thrash out their utilization in appraising soil fertility.

Radioisotopes

Many elements found on Earth exist in different atomic configurations are called isotopes, which have the same atomic number but differ in atomic mass. These unstable elements decay, releasing energy in the process. These isotopes that emit radiation are called radioisotopes. In simple terms, the isotopes with unpredictable or unstable nuclei are called radioisotopes. Radioactive atoms are unstable since ensure amalgamations of neutrons and protons generate nuclei with quiescent uncertainty. Individually unstable concoction is distinguished by a corroborate signify life expectancy. The corrode of a shown radioactive atom is arbitrarily barely owing to the concomitantly accomplishment of several stipulation. They putrefy spontaneously with a featured quality of decompose ratio. Radioisotopes radiate quite-a-few extraordinary kinds of vitality in the form of radiation (alpha, beta, and gamma) that are quite useful to beings in small quantity. These rays are penetrating, invisible and spontaneous. Their existence can be straightforwardly discerned employ the recent appliance viz. Geiger-Muller and scintillation counters. These kinds of apparatus are applied to expose even the minute and very small quantity of radioactive elements are contemporary. Hence, the radioactivity of the recent mini tool substantiates to be very advantageous in numerous fields of diurnal use for a purpose such as in industry, agriculture and medicine. At this moment in time, the radioisotopes are extensively applied in the background of agriculture than in any other stream of science, and their utilization guide us us to resolve several agricultural problems in a short period and more precisely. Consequently, radioisotopes have become a extremely significant utility tool for scientists captivated in get to the bottom of agricultural issues. Furthermore, radioactive causes and tracers for radiation have become necessary for all perplexed bottlenecks of agricultural research. Radiation and radioisotope provides us the likelihood to expound the once enigmatic algorithms involved in the nourishment and bourgeon of plants and the buildout of current plant varieties.

They help us eradicate the arbitrary determinants that adversely impact the plants in dissimilar methods.

Type of Radioisotopes

(i) Stable isotope: - No decay and no radioactivity.
Stable isotopes are non-radioactive forms of atoms. Although they do not emit radiation , their unique properties allow their use in a variety of overseas applications, including water and soil management, environmental studies , nutritional assessment studies and forensics.

Examples : ^{2}H, ^{13}C,^{15} N,^{18}O

- Utilization for labelled compounds as possible intermediates in biosynthetic pathways.
- Usual method of detection are:- MASS Spectroscopy [^{15}N, ^{18}O].
- NMR Spectroscopy [^{2} H, ^{13}Cl]

(ii) Unstable isotope : Decay with emission of radiation.
Radioactive decay and emitted alpha, beta and gamma radiation. These unstable nuclei have excess energy and this is released by their decay into stable lower energy forms, with the excess being released in the form of radiation, mainly alpha (**α**), beta (β), and gamma (γ), and they are called radioactive.

Example:- ^{2}H, ^{14}C,^{35}S,^{131} I, ^{24}Na, ^{42}K, ^{35}S, ^{35}P.

- For biological investigation- carbon and hydrogen
- For metabolic studies- S,P and alkaline earth metals are used.
- For studies on proteins, amino-acids are referred to as the nitrogen atom, alkaloids give more specific information.
- ^{3}H compound is commercially available.

Stable Isotopes in Agriculture

Stable isotopes are employed in soil and plant analyses in the similar manner as radioactive isotopes. At a period of time radioactive isotopes radiate particles that are captured in photomultiplier tubes, numbered stable isotopes are detached from one another by flowing a gas comprising them through a potent magnetic field that divert them antagonistically as per to their mass. The most commonly used stable isotope is 15N, however a large number of other stable isotopes are produced and are progressively avail of in agricultural scrutinize **(Table 1).** Nitrogen is one of the most important limiting factors for plant growth. There are twelve nitrogen isotopes, many with extremely short half-lives. Of the radioactive isotopes, only ^{13}N with a half-life of 9.97 minutes has been adopted mostly in plant nitrogen translocation experiment ***(Caldwell et al., 1984).*** Two stable isotopes of N **(Table 2)** occur intuitively in atmospheric N2.

Table 1 : Some useful stable isotopes in commercial production.

ATOMIC NUMBER	ISOTOPES
6	^{13}C
7	^{15}N
8	^{18}O
12	^{25}Mg

ATOMIC NUMBER	ISOTOPES
14	^{28}Si
16	^{33}S
	^{36}S
26	^{54}Fe
30	^{68}Zn
82	^{208}Pb

Source : *Adapted from IAEA Bulletin NO.14, 2001.*

Table 2 : Several isotopes of nitrogen

Mass number	Natural abundance %	Half-life (time)
12		-0.0125 sec
13		10.05 min
14	99.634 (light)	-
15	0.366 (Heavy)	-
16		7.36 sec
17		4.14 sec

Source : *Adapted from IAEA Bulletin NO.14, 2001.*

Radioisotope in soil Fertility Evaluation

- **Evaluation of radioisotope fertility in soil Tracer technique :** The tracer method is formulated on the hypothesis that when a plant accomplishes a particular nutrient from the soil and a fertilizer appended, the quantity accessible in the soil relative to a standard fertilizer can quantified, if regarding from the known fertilizer. The hindmost is probable by utilizing a stable isotope or radioactive of the nutrient in consideration with the fertilizer. Some of the plants are grown in soil to which is added a phosphate fertilizer mixed with a very small quantity of phosphate with radioactive ^{32}P. The soil firstly consists a known quantity of non-radioactive phosphorus, such as phosphatic fertilizers, anticipate for the small quantity of ^{32}P that was append on motive. Following appropriate growth and development period, the plants are reaped and the total amount of P and ^{32} P content resolute.
- **Estimation of the available nutrients in the soil:** The analysis of the accessible soil nutrients is of substantial significance for the arrangement of an optimal application of fertiliser. Of various existing techniques for evaluating accessible soil nutrients, isotopic techniques have influenced awareness in this field.
- **L Value:** L value was initially proposed by Larsen, 1952, that when labelled phosphate fertilizers were amended to a soil at various amount and plants were cultivate, the peculiar undertaking analysis of the plant material gave a ceaseless value, pretending that the isotopic dilution of the apprehended alchemical was in the floor system come to pass. The purpose for the constant value attained is ascribed to the balance reached between added phosphate and the exchangeable phosphate in the soil. The quantity measured in this way is referred to as the L value and this quantity is also referred to as the labile phosphorus of

the labile pool. The L-value can be considered as an E-value, using the plant as a means of sampling the solution after the equilibrium of added P with exchangeable soil P, with the additional advantage that in this method the conditions are identical to those are that prevail in the soil and plant system.

- **E value:** This procedure is a direct utilization of the isotope dilution principle. The quantity of nutrients in the soil in equilibrium with the same nutrient in the soil solution can be quantified using the E value. The reaction can be represented as fallow:

$$\text{Surface } {}^{31}P + \text{Solution } {}^{32}P - \text{Surface } {}^{32}P + \text{Solution } {}^{31}P$$

At equilibrium,

$$\frac{\text{Surface } {}^{31}P}{\text{Surface } {}^{32}P} = \frac{\text{Solution } {}^{31}P}{\text{Solution } {}^{32}P}$$

With this technique it is feasible to calculate both the intensity factor and capacitance as well of the similar sample. The E value embodies the labile form of the nutrient and embodies the overall quantity of nutrient experiencing isotopic dilution.

- **A Value:** The A-value concept was evolved by Fried, 1952. When the plant is bestow with two causes for a listed nutrient, the plant do soak up from each of those reasons in ratio to the quantity accessible at one and all. The quantity of accessible nutrients in the soil to be defined in comparison with fertilizer standards is known as the A value. Arithemetically, the A value can be expressed as:

$$A = B \frac{(1-Y)}{Y}$$

Where,

A = Amount of available nutrient in soil
B = Amount of applied fertilizer nutrient
Y = proportion of nutrient in the plant derived from the fertilizer nutrient.

Table 3 : Isotopes of Nitrogen and their typical applications

Isotope	Natural abundance (atom%)	Typical applications
^{13} N	Trace	✓ N-fixation ✓ Denitrification
^{14} N	99.63	✓ ^{14}N enriched materials for single season fertilizer use efficiency (FUE)
^{15}N	0.368	✓ FUE , biological N fixation. ✓ N transformation in soils (N-cycling). ✓ Animal nutrition studies. ✓ Nitrate pollution in groundwater.

Source : *Zapata, 1990*

Table 4 : Isotope of phosphorus with typical applications.

Isotope	Half life (days)	Typical applications
^{32}P	14.26	✓ Fertilizer use efficiency (FUE) ✓ Residual P fertilizer studies. ✓ Root activity pattern of crops.
^{33}P	25.34	✓ Root autoradiography ✓ Double labelling for rot. ✓ Activity pattern of crops. ✓ Fertilizer use efficiency.

Source : *Zapata, 1990*

Organic Residues studies

- **^{15}N Direct Labelling Techniques:** Cover crop and crop residue research utilizing the straightforward technique are moderately straightforward. Green manure can be effortlessly acquired by planting crops that have been dress with fertilizers with ^{15}N tracer; The material above or below ground is then harvested and added as residue to unmarked soil where the next crop will be grown. This crop is then harvested and the percent nitrogen content in the crop determined from added residues is measured using the following equation ***(Hauck and Bremner, 1976).***

$$\% \text{ Ndfr} = \frac{\text{Atom \% } ^{15}\text{N excess in the crop}}{\text{Atom \% } ^{15}\text{N excess in the added residue}} \times 100$$

- **Indirect Techniques:** Indirect techniques were implemented to swot plant N uptake from organic left over. ^{15}N tracer is added to the soil and crop residue and no crop residue control or treatments are developed. The residue-free regulates show ^{15}N assemblage throw back the soil 15N pool, and the residue critique should illustrate lower ^{15}N assemblage owing due to input of unlabelled Nitrogen(N) from the decaying crop leftover. This is the similar concept as the ^{15}N dilution method for assuming biological nitrogen fixation (BNF). The nitrogen (Ndfr) determined from the residue is quantified using the following equation.

$$\% \text{ Ndfr} = 1 - \frac{\text{Atom \% } ^{15}\text{N excess residue treatment}}{\text{Atom \% } ^{15}\text{N excess no residue control}} \times 100$$

Realistically, it has been revealed that the **concomitantly** utilization of ^{15}N label and crop residues results in errors relevant to pool substitution ***(Hood, 1999).*** Consequently, it is suggested to highlight the ground with 15N prior to using the crop remaining and grant up to 6 months to balance equally.

- **Carbon-14 Dating: -** Carbon dating is a methodology for dictating eternity of organic materials. This is frequently applied to carbon-date burial site of soils. In spite of the that some calculations have been generated on recent soils. Radiocarbon dating calculates can be generated on charcoal, freshwater shells, wood and marine, antlers, and bones, and organic sediments and peat. Carbon has three naturally occurring isotopes. ^{12}C and ^{13}C both of them

are stable, apart form ^{14}C putrefy by through extremely weak beta decay to ^{14}N with the interval of time required for one-half of the atomic nuclei of a radioactive sample to decay about 5,730 years. Radiocarbon, naturally eventuate a subordinate consequence of cosmic ray attack, bombardment and as well as assault of the upper atmosphere. Plants transpire to take up atmospheric carbon, which is the commencement of carbon uptake into the food chain. Animals eat the plants and this action introduces carbon into their bodies. After the organism dies, carbon-14 continues to be broken down without being replaced. To measure the amount of radiocarbon left in an artifact, scientists burn a small piece to turn it into carbon dioxide gas. Radiation counters are used to detect the electrons released by the decay of ^{14}C as it turns into nitrogen. The amount of ^{14}C is compared to the amount of ^{12}C, the stable form of carbon, to determine how much radiocarbon has decayed, thereby dating the artifact. Soil organic matter turnover is usually too rapid for age measurements using the ^{14}C dating technique, particularly in soils where turnover is not constrained by drought, waterlogging and low temperatures.

Element	Stable isotope	Radio isotope	Typical application
Carbon	^{12} C	^{14}C	Photosynthesis, SOM studies, carbon balance.
Hydrogen	^{1}H	^{3}H	Water movement, biochemical studies.
Oxygen	^{18}O, ^{16}O	^{15}O ,^{13} O	Photosynthesis, respiration, hydrology
Potassium	^{39}K	^{42}K	Ion uptake mechanism,
Magnesium	^{24}Mg	^{24}Mg	Movement in plant
Sulphur	^{32}S	^{35}S	Availability from soil; uptake from soil and water.
Iron	^{56} Fe	^{59}Fe	Soil erosion; movement in soils and plants.
Chlorine	^{35}Cl	^{36}Cl ^{35}Cl	Solute movement in soil, herbicidal effects on life forms.
Cesium	^{133}Cs	^{134}Cs ^{137}Cs	Soil erosion (sediment movement and deposition)
Boron	^{11}B, ^{10}B	^{12}B	Foliar absorption , soil moisture studies.
Molybdenum	^{96}Mo	^{99}Mo	Plant nutrition

Source : *Zapata, 1990*

Conclusions

Radioisotopes are utilized to improve the quality and yield of agricultural products and to optimize the use of fertilizers without harmful effects on plants and humans. The radio labelled fertilizer was used to study fertilizer uptake, retention and utilization. It is understood that in addition to the marathon efforts of scientists and engineers engaged in the development of nuclear science and technology, the media's sincere efforts to popularize and disseminate the beneficial use of radioisotopes for national development will play an important role in the realizing Atom's full potential.

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ACCELERATED BREEDING APPROACHES IN POTATO

Jyothsna J
Research Scholar, Department of Horticulture
College of Agriculture, Jawaharlal Nehru Krishi Vishwavidyalaya
Jabalpur, Madhya Pradesh

Abstract
Potato is a globally essential food crop that produces more food per unit of land area, in comparison to the major food crops. Potato contains species of polyploid nature ranging from diploid, triploid, tetraploid, pentaploid and hexaploid nature. This polyploidy nature is the result of sexual polyploidization through 2n gamete formation. The first potato introductions were of *S. tuberosum* subsp. *andigena* that are adapted to short days with long dormancy. At the end of World War II, many long-day-adapted European cultivars were introduced. The conventional breeding program includes biparental crossing followed by selection. The interspecific hybridization works are rare. The desired plant type is fixed in the F1 generation and maintained through clonal propagation by tubers. Through this scheme, a new variety development takes 10 and more years, due to the time required for seed increase from a single selected plant. There arise the need for accelerated breeding approaches in potato improvement.

Introduction
Potato is a globally essential food crop that produces more food per unit of land area, in comparison to the major food crops. The genus *Solanum* is rich in its species diversity including 107 wild species and 4 landraces/traditional cultivated species. The tuber-bearing wild relatives are placed under section Petota. All the cultivated species are placed into a single species, *S. tuberosum*, bifurcated into two cultivar groups namely Andigenum group and Chilotanum group. The first group Andigenum includes all diploid, triploid and tetraploid potatoes originating from the Andes, Venezuela and Argentina. The second group Chilotanum includes tetraploid potatoes that are native to south-central Chile. Potato contains species of polyploid nature ranging from diploid, triploid, tetraploid, pentaploid and hexaploid nature. This polyploidy nature is the result of sexual polyploidization through 2n gamete formation (Spooner *et al*., 2010). It was believed that the first cultivated potatoes were diploid. The extensive gene flow within and between different ploidy species leads to today's highly heterozygous polyploid potatoes.

Initial breeding efforts in potato improvement
Potato is native to the Andean region of South America. Andean farmers were the early breeder who conserved its diversity. The progress in breeding potatoes started when Thomas Andrew Knight made cross pollination in potatoes. In the USA, Rough Purple Chili, Garnet Chili and Early Rose were the first few cultivars raised. Russet Burbank is a predominant cultivar in the USA that still occupies a significant area under cultivation.

In India, the potato was introduced in the 17th century by either Portuguese traders or British missionaries (Pushkarnath, 1976). The first potato introductions were of *S. tuberosum* subsp. *andigena* that are adapted to short days with long dormancy and were able to withstand high temperatures in storage houses. However, at the end of World War II, many long-day-adapted

European cultivars were introduced. These cultivars didn't become a success under Indian conditions whose climate is of short-days.

The systematic research on potato breeding in India was begun at the Potato breeding station, Kufri, Shimla which was under IARI, in 1935. The varietal development was challenged due to the long-day nature, accumulation of viral diseases and inability to store tuber storage in hot and humid conditions. The potato flowers only under long day conditions and that's why potato hybridization was started in the hills of Kufri, Shimla, Himachal Pradesh. The initial attempts at potato breeding for high yield and adaptation to subtropical plains were unsuccessful owing to the degeneration of progenies during the evaluation period. To overcome this problem, the seedlings were grown and maintained on the hills of Kufri and only their tuber/clones were sent to the subtropical plains for evaluation. This strategy also failed due to the long dormancy of hill seeds and land limitations in the Kufri hills. Then came the breakthrough in 1963 called the 'Seed Plot Technique', which involves raising, evaluating, selecting and multiplication of breeding material under disease-free conditions in the Indian subtropical plains itself. This strategy gave rise to a system in which crosses were made on hills and the resulting populations were evaluated and maintained in the disease-free condition on the plains itself. Using this approach, nearly 62 improved varieties were developed and released by ICAR-CPRI (Sood *et al*., 2020).

Challenges in potato breeding

In cereal breeding, first, the homozygous lines were obtained that are subjected to the crossing and consequent hybrid development. But, the hybrid development process is entirely different in potatoes. Cultivated potatoes are autopolyploid and highly heterozygous, wherein for hybrid development the heterozygous lines were crossed with donor heterozygous genotypes and desired genotypes were selected in the F1 generation itself. In such a system, the hybrid cannot be reconstituted again through TPS since every TPS in F1 is genetically different in potatoes. The homozygous lines couldn't be developed in potatoes due to high inbreeding depression in tetraploid species and self-incompatibility in diploid species (Bradshaw, 2009). These two limitations restricted the introgression of biotic and abiotic stress-resistant genes from wild species into cultivated types.

Besides, the polysomic inheritance renders the following constraints in potato breeding.

i. Genetic studies are complicated
ii. Mendelian ratios do not correspond to genes at the distal end of centromere
iii. Unexpected homozygote results due to the double reduction phenomenon
iv. Large populations are needed to screen and identify transgressive segregants
v. Deleterious recessive genes are linked with the functional genes
vi. Epistatic interactions are largely expressed (Jansky and Spooner, 2018)

Current potato breeding programs

The conventional breeding program includes biparental crossing followed by selection. The interspecific hybridization works are rare. The desired plant type is fixed in the F1 generation and maintained through clonal propagation by tubers. Through this scheme, a new variety development takes 10 and more years, due to the time required for seed increase from a single selected plant. There arise the need for accelerated breeding approaches in potato improvement.

Approaches to accelerate potato breeding

The following approaches are employed to speed up the breeding process coupled with increased genetic gains.

a) Marker-assisted breeding

Development in molecular biology has enabled better knowledge of genetic regions linked to resistance to diseases and pests. Breeding for resistance in potatoes through pyramiding resistant genes (incorporation of several different genes) has started and been well explored. The marker-assisted selection (MAS) is been successful in disease resistance breeding in potatoes. Attempts on pyramiding late blight resistant genes, R genes, into one cultivar would increase the level and durability of resistance (Kim *et al*., 2012).

At ICAR-CPRI, parental lines for late blight resistance were selected from a collection using molecular markers that are associated with R1, R2 and R3 genes (Sood *et al*., 2020). Chakrabarti and others (2014) identified major QTLs for late blight resistance using AFLP and SSR markers. MAS is being used for all major viruses and potato cyst nematode resistance. Kaushik and team (2013) developed a triplex potato line with Ry_{adg} that show extreme resistance to PVY. The molecular markers associated with Ry_{adg} have also been used to select genotypes with PVA resistance (Sood *et al*., 2020).

For potato cyst nematode (PCN) resistance, two sources namely *S. tuberosum ssp. andigena* and *S. vernei* are prominently being used. Molecular markers are available for choosing PCN-resistant genotypes. Dynamic research has mapped several loci that are linked with resistance against *G. pallida* and *G. rostochinensis*. To date, 19 genes have been identified on the potato chromosome map.

b) Diploid hybrid breeding

Chase (1963) proposed a novel scheme of diploid breeding in potatoes to explore the genetic diversity of wild potato relatives. This scheme involves the reduction of ploidy of tetraploid potatoes to diploid level, followed by hybridization at diploid level with diploid wild species and polyploidization of selected diploids back to tetraploid level. Diploids have been reported to express high tuber yield potential than tetraploids, indicating that the ploidy reduction and breeding at the diploid level paves way for exploring heterosis (Carroll, 1982; Jansky and Spooner, 2018). It is easy to raise the ploidy level, but reducing the ploidy level is difficult.

Nature poses restrictions to diploid breeding through inbreeding depression in tetraploid species and self-incompatibility in diploid species. There are two approaches to developing diploid lines in tetraploid species. The first method is the androgenesis through which monoploids (1x), followed by chromosome doubling (Veilleux, 1990). However, androgenesis is rarely occurring in most potato genotypes. The second method is based on the natural self-incompatibility inhibitors (*sli* gene) from *S. chacoense* (Phumichai *et al*., 2005). Lindhout and others (2011) proved the concept of the diploid hybrid potato.

ICAR-CPRI started the development of diploid inbred lines through *sli* gene and imported the diploid population from USDA, USA. They have developed a series of diploid inbred lines with favorable genes. It is recommended that the inbred lines can be maintained as true potato seeds

(TPS) (Sood *et al*., 2020). This diploid hybrid breeding scheme enables varietal development within 5 years compared to more than 10 years in conventional breeding techniques.

c) Speed breeding

Speed breeding is another arising technology wherein 4-6 generations can be easily hastened by growing under controlled conditions. This technique enables acceleration of genetic gain and reduction of the generation time of the breeding cycle. The speed breeding strategy involves the creation of an artificial environment with enhanced light duration for a longer day length to speed up the breeding cycle of the crop. It was reported that extended daylight induced early flowering and reproduction and enhanced genetic gain. It involves supplemental lighting (22 hours/day) that enhance the photosynthesis rate and subsequently, the generation cycle is hastened through the single seed descent method (Watson *et al*., 2018). In potatoes, the speed breeding could be coupled with an aeroponic growing technique to reduce the long breeding cycle (Sood *et al*., 2020).

d) Genomic selection

When accessible molecular markers are sufficient to densely cover the genome of the animal or plant species, genomic selection (GS) was presented in 2001 as an alternative to marker-assisted selection (MAS). All markers are fitted together in a single-step prediction model in genomic selection (GS). To achieve good prediction accuracies for dry matter and chipping quality, Sverrisdóttir and team (2017) suggested 10,000 markers.

e) Genome editing

Random mutagenesis has some drawbacks, including the production of several undesired rearrangements and mutations that are both costly and difficult to detect. Engineered site-specific nucleases (SSNs) are used in genome editing to delete, insert, or replace a DNA sequence. Engineered endonucleases, such as zinc finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), and clustered regularly interspaced short palindromic repeat (CRISPR)/CRISPR-associated protein 9 (Cas9), have paved the way for single nucleotide excision mechanisms for crop improvement (Arora and Narula, 2017). The first successful targeted mutagenesis resulted in a mutant with the SSR2 gene knocked off by TALENs (Sawai *et al*., 2014). In potatoes, the granule-bound starch synthase I (GBSSI) gene is commonly used as a model target for genetic engineering. In potato tubers, a GBSSI-deficient mutant reveals amylose-free starch.

Amylose-free starch has a high commercial value and is utilized in the food and paper sectors. Because site-specific mutations must be present on all four target gene alleles, a powerful and novel method is necessary to create a potato mutant. The use of the dMac3 translational enhancer resulted in a significant increase in the efficiency of mutagenesis (Andersson *et al*., 2018). Potato's acetolactate synthase (ALS) gene was recently edited via genome editing, and it was found to confer lower herbicide sensitivity (Butler *et al*., 2015). Similarly, self-compatible diploid potatoes have been generated by employing genome editing to knock out the self-incompatibility gene S-RNase, bringing up new possibilities for diploid potato breeding (Ye *et al*., 2018).

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ANTIBIOTIC USE AND RESISTANCE IN ANIMAL HEALTH CARE SETTINGS

Saroj Rai* and Rani Alex[1]

ICAR-National Dairy Research Institute,
Eastern Regional Station, Kalyani, West Bengal
[1]ICAR-National Dairy Research Institute, Karnal, Haryana
***Corresponding Author : drsaroj.rai@gmail.com**

The global consumption of antimicrobials in food animals was estimated at 131,109 tons in 2013 with a projection that it would rise up to 200,235 tons by 2030 (Van Boeckel et al., 2017). India alone accounts for about 3% of the global consumption of antimicrobials in food animals (Van Boeckel et al., 2015). There is widespread use of antibiotics in animals by untrained animal care givers leading to subsequent antibiotic abuse and antimicrobial resistance (AMR). Therefore, humans living in close proximity to the livestock are at continuous risks of Zoonotic pathogens and Antimicrobial Resistance (AMR).

When Antibiotics is used, microorganisms respond by being resistant. The Antimicrobial resistant genes (ARGs) present in them get transferred to other pathogens through mobile genetic elements. Use of antibiotics and failure to observe withdrawal period results in contaminated products concerning human safety and health. Treatment offered by the unqualified persons with limited knowledge is dangerous. But what these individuals offer is cheap, readily accessible quick fix to the farmers. Wide variety of study have given us the information on antibiotic access (Kumar and Gupta, 2018), treatment by animal health care givers, farmers (Garg and Mohanta, 2012; Chauhan et al., 2018), improper disposal of milk from sick and treated cows, addition of antibiotics to animal feeds and water and for growth promotion (Parkunan et al., 2019),) etc. Veterinarians are also few in numbers and their engagements in outreach programmes are enormous.

Therefore, there is a need for adoption of stringent regulations on antibiotic use in livestock otherwise AMR complexities may cause HAVOC. At present, all classes of antimicrobials are shared by humans and animals, including the newest classes of drugs third and fourth-generations. Colistin, a growth promoter is now banned on animals (The Week., 2019) is now being used in treatment of life threatening infections in humans (Collignon and McEwen, 2019). *E. coli,* a gram *negative* facultative anaerobe mostly commensal, is worrying because of its resistance to the third generation antibiotics especially the Extended Spectrum Beta Lactam (ESBL) positive strains which have shown high cross resistance to fluoroquinolones and gentamicin (European Medicine Agency, 2013). The Genetic distances between human and livestock bacteria were low in people who did not regularly wash their hands before eating (Innocent *et al.,* 2008). Contamination of milk with antibiotic residues has been reported in several studies is either fed to calves, sold for human consumption or disposed (Kumar *et al*., 2018).

So there is Urgent threat and Urgent need to address the problem by adoption of better policy on Antibiotic use and Abuse in Animal Health Care settings.

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DIFFERENT IRRIGATION AND FERTIGATION STRATEGIES UNDER PROTECTED CULTIVATION

Vivek Kumar Patel[*], Saipayan Ghosh[**], Samiksha[***] and Subhashi Kumar[*]

[*]Department of Plant Pathology, PGCA, RPCAU, Pusa, Samastipur, Bihar, 848125
[**]Department of Horticulture, PGCA, RPCAU, Pusa, Samastipur, Bihar, 848125
[***]Department of Horticulture, SHUATS, Prayagraj, (U.P) 211007
Corresponding author: saipayanghosh500@gmail.com

Abstract

Under adverse climatic conditions, it is highly challenging task to produce crops. Weather and climatic conditions have significant role in determining the rate of crop production,. However, there is no scope for any restrictions during times when global food security is heavily dependent on crop production. Therefore, cultivation and crop production under controlled environment is significant solution. Under controlled climatic conditions, cultivation in greenhouse is one of the essential variants in farming. Greenhouses are constructed with an intention to provide optimal conditions of growth as well as for protection from adverse weather and different pests. In recent decades, the application of plant protection agents through irrigation systems such as herbicides, fungicides, insecticides, growth regulators and biocontrol agents has enhanced rapidly.

Keywords : Drip irrigation, fertigation, greenhouse, water use efficiency

Introduction

Greenhouse production systems decrease crop water requirements by as much as 20% to 40% compared to open field cultivation; however, growers routinely apply more irrigation water than the estimated water consumption. Considering the number of different plant species grown in prevailing greenhouse environments, the types of substrate and container sizes, field and soil characteristics, and the different irrigation systems, it becomes obvious why irrigation scheduling becomes complex if it is to be achieved with any level of precision. The precise amount of irrigation required in each day throughout the year can be supplied efficiently by a well-designed irrigation system in greenhouse. The irrigation requirement depends on cultivated area, type of crop, weather condition, timing of cultivation, capacity of ventilation requirement etc. The irrigation systems used in greenhouse are hand writing, perimeter watering, overhead sprinklers, boom watering and drip irrigation.

Hand watering

Hand watering is the most traditional method of irrigation and is uneconomical in today's times. It is very tedious and takes considerable time to operate. The growers can afford hand watering for high density crop, irrigating specific pots and areas which dries earlier than others. For hand watering, a water breaker needs to be placed on the end of the hose. For a higher flow rate condition, the force of the water should not wash the root substrate out of the bench or pot.

Perimeter watering

The perimeter watering system may be used on benches or beds for crop production. A standard device consists of a plastic pipe with nozzles spraying water over the surface of the substrate below the vegetation across the circumference of a bench. Nozzles are constructed by using nylon

or hard plastic material and a spray arc of 180°, 90° or 45° can be applied. They are staggered around the benches, irrespective of the types of nozzles used, so that each nozzle projects between two other nozzles on the opposite side.

Overhead sprinklers

For disease control, the foliage on most crops should be kept dry though wet foliage is tolerated by a few crops. These few crops can be irrigated from overhead more quickly and cheaply. The height of 0.6 m and 1.8 m is sufficient for flat bedding plants and fresh flowers, respectively. There is a nozzle installed at the top of each riser. Nozzles vary from those that cast a 360° pattern continuously to forms that spin around a 360° globe. Drainage of excess water is passed through drain holes of the trays and certain quantity of water is stored in the tray, which is subsequently absorbed by the substratum.

Boom watering

Boom watering, which is often used to produce seedlings grown in plug trays, can act either as an open system or as a closed system. Each seedling is produced in its own individual cell. The precision of watering is very important during the 2 to 8 weeks development cycle of plug seedlings. A boom watering system generally consists of a water pipe boom that extends from one side of a greenhouse bay to the other. The boom will move from one end of the bay to the other. The boom is propelled by an electric motor. The amount of water delivered per area of the plant unit is adjusted by the speed at which the boom is moving.

Drip Irrigation

Drip irrigation, also known as trickle irrigation, consists of the lying on the surface or subsurface of the field or greenhouse of small-diameter plastic tubes beside or below the plants. Drip irrigation is the only way to add standardized water and fertilizer to the plants without using plastic mulches, row covers, or greenhouses. Drip irrigation provides complete control over environmental variability; retains optimum production with minimal use of water while retaining soil and fertilizer nutrients; and controls the cost of water, fertilizer, labor and machinery. Drip irrigation is the safest method of water management. Depending on soil type, field level and how water is applied to the furrows, the application efficiency is usually 90 to 95 percent; compared with 70 percent sprinkler and 60 to 80 percent furrow irrigation.

Advanced Micro-irrigation Systems for Greenhouse

Micro-irrigation systems for greenhouse can be broadly categorized into aerial, surface, and subsurface passing of drip lines. There are two types of lateral mains can be adopted that differ depending on how the emitters are installed, that is (1) in-line emitters or driplines and (2) online emitters.

Fertigation in Protected Cultivation

With fertigation, the nutrient is applied with irrigation water in the form of soluble fertilizer expected to meet most crop needs according to their stage of development.

The success of fertigation depends primarily on the characteristics of the fertilizers used. Those are:

- Must be completely soluble in water (< 0.02% insoluble in water) and have quick dissolution in water with minimum content of conditioners.

- Must not react with dissolved elements in water especially calcium and magnesium salts.
- High nutrient content in the saturated solution must not get leached down easily from the soil.
- Should not change the pH of water leading to precipitation and clogging
- Should avoid corrosion of the system.
- Should be safer for field use and for mixing with other chemicals.

Common fertilizers suitable for fertigation in protected cultivation

1. Chloride free fertilizers

These fertilizers are produced by using Urea, ammonium nitrate phosphate and potassium nitrate as basic ingredients and are useful for high value crops and crops which are more sensitive to the chloride injury. Ex: Tobacco, grapes, citrus, arecanut and vegetables.

2. Liquid fertilizers

Bulk fertilizers such as ammonium sulphate, ammonium nitrate, urea, ammonium phosphate, phosphoric acid, potassium nitrate, potassium chloride, potassium sulphate, etc. are primarily the raw materials used in the manufacture of liquid fertilizers. The liquid fertilizers do not precipitate and are pure. The liquid fertilizers are typically acidic (pH 5.5-6.5) and help to some degree to correct the soil pH and also help avoid the clogging of emitters. Liquid fertilizer with a neutral pH or even higher pH may be used for acidic soils.

3. Normal fertilizers

These are produced by using ammonium nitrate, urea, ammonium phosphate, ammonium sulphate, phosphoric acid, potassium chloride etc.

4. Micro nutrients

Micronutrients are generally applied separately to plants in most soils as their application through fertigation would react with salts in the irrigation water and cause precipitation and clogging.

Precautions to be taken during fertigation

- Deposits or residues free materials should be used and it must be non-corrosive to the system.
- Constant operating pressure should be maintained to facilitate uniform mixing of water with fertilizers.
- Most appropriate fertilizer, injection system and crops for fertigation should be selected.
- Prior to fertilizer injection, the drip irrigation system should be allowed to run at its working pressure.
- At the same time, fertilizers, pesticides and chlorine should not be injected.

Conclusion

Drip fertigation helps in proper utilization of fertilizers, saves labour and increases the productivity of vegetable crops. Apart from higher yield, higher resource use efficiency, higher benefit cost ratio is also obtained in drip fertigation. Drip irrigation cum fertigation increases the yield due to higher nutrient uptake and thereby improves water and fertilizer use efficiency. In turn fertilizer could be saved to the tune of 25 to 50 per cent through drip fertigation.

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AGRICULTURAL DRONE – APPLICATIONS AND CHALLENGES

Ghanshyam Panwar[1]* and Sanjay H. Parmar[2]
[1] Ph.D. scholar, Department of Farm Machinery and Power Engineering
[2] Ph.D. scholar, Department of Irrigation and Drainage Engineering
College of Agricultural Engineering and Technology, AAU, Godhra

Abstract
Agricultural drones have made significant technological progress in recent years. Drones deliver high-resolution crop images as well as several indices that are useful in making farm management decisions. Drones have revolutionised farming methods by allowing farmers to save money, improve operational efficiency and increase profitability. Agricultural drones have gained popularity over time, attracting the interest of researchers, manufacturers, and the government. However, there are a number of challenges with drone technology that must be addressed in order to successfully deploy it in agriculture.

Introduction
The main source of food for the population of the world is agriculture but it has been facing challenges because of increasing demand for food products, food safety and problems such as environmental protection, water conservation, and sustainability. The world's population is estimated to be 9.7 billion by 2050 (Rajeb *et al*., 2022). The solution for these problems of agriculture and increase in agricultural production is the use of technology. Drone technology with advanced image data analytics has the potential to fill the gap between current agricultural production and the needs of the future.

Drone also known as Unmanned Aerial vehicle (UAV) is a vehicle/aircraft that can be operated remotely without a pilot on board or autonomously. The drone can be programmed to travel the predefined path using navigation algorithms. Drones consists of a propulsion system, a programmable controller with or without the satellite navigation system, automated flight planning features and capable of carrying payload such as cameras, spraying systems, etc. for accomplishing a given task. Drones have sensors that can provide real-time information about the crop status or livestock movement. A drone may have different sensor systems for digital imaging such as multi spectral, high-resolution camera systems and actuators which help in field survey, crop scouting, spraying and surveillance in livestock and fisheries. The data captured through cameras mounted on drone farmers can be used for calculation of precise land sizes, classification of crop types and verities, development of soil maps along with pest management, proper planning of harvesting of crops and scheduling of farm machineries using data analytics. Drones have been frequently classified using some of the performance characters such as weight, maximum altitude, wing load, engine type, power source and flight range. According to ministry of civil aviation, drones are classified based upon the maximum all-up weight including payload as under-

1) Nano drone: Less than or equal to 250 gram
2) Micro drone: Greater than 250 gram and less than or equal to 2 kilogram
3) Small drone: Greater than 2 kilogram and less than or equal to 25 kilogram

4) Medium drone: Greater than 25 kilogram and less than or equal to 150 kilogram
5) Large drone: Greater than 150 kilogram.

Application of drones in agriculture

1) Assessment of crop health: Drone with infrared cameras is used for development of Normalized Difference Vegetation Index (NDVI). The NDVI view of an area is used for the analysis of the intensity of solar radiation absorbed and therefore the condition of the monitored plants and its specific parts. This information helps in early identification of pests and diseases.
2) Crop surveillance: Drones based agriculture mapping keeps farmers updated on the plants status and point out which field areas require attention. Based on these inputs, farmers can take measures to improve the state of plants in any spot of the field.
3) Crop Insurance: Advanced geospatial NDVI products can also be used in case of natural disasters or destruction of crops to precisely estimate the level of losses by comparing the pre-disaster state of vegetation with the damages that occurred. Precise documentation of damages followed by precise estimation of reduction in estimated yields can be used in insurance procedures.
4) Livestock management: Drones equipped with high resolution cameras used for counting animals using their heat marks. It also used for identification and treatment of ill animals based on a temperature comparison.
5) Spraying: Drones with suitably sized reservoirs can be filled with fertilizers, herbicides, or pesticides for crop spraying on large areas in less time. For efficient use of chemicals, the spraying needs to be synchronized with the imaging, processing and automated analytics.
6) Assessment of soil condition: Drone technology can be utilised to analyse soil condition and consequently predict yields before the vegetation cycle begins. Actual 3D mapping of the terrain with precise soil colour coverage is the most important application in analysing soil condition. This helps in the exact assessment of soil quality, moisture, and water movement.
7) Irrigation management: Drones equipped with hyper-spectral, multi-spectral or thermal sensors can detect moisture deficient regions using the vegetative index. This aids in the precise planning of irrigation to the designated regions.

Challenges of drones in agriculture

1) Initial cost: Agricultural drones are expensive as it includes cost of sensors, software, hardware and tools. The initial cost also depends on the payload and flight time capacities.
2) Data management: As the drones have accuracy and precision of information, the size of datasets is large. So, it becomes difficult to manage all data.
3) Quality software: Software plays a crucial role in the applicability of drone technology from flight path planning to process the image data. So, drone technology needs quality software for better results.
4) Weather dependency: Drones activities are intensely subject to climatic circumstances, accordingly restricting their utilization. Flying drones is difficult under rainy or stormy circumstances.

5) Poor connectivity: In most cases farmlands does not have sufficient connectivity, under such circumstance the farmer needs to invest in connectivity or purchase a drone capable of collecting data locally for later processing.
6) Knowledge, Skill and acceptability by the farmers: Farmers don't have the technical knowledge to analyse the drone images and other data. Due to this lack of technical knowledge, it is difficult for farmers to accept it.

Conclusions

Drone technology is a tool for increasing agricultural output, and it has a lot of potential for efficiently carrying out a variety of agricultural tasks. It can save labour and advanced technology attracts young people to farming. However, high initial cost and technology gap are some of the challenging aspects of making it farmer-friendly which can be overcome by involving of custom hiring centers, training centers and emerging start-ups. There is also a need to perform research in order to improve operation protocols as well as calibrate and validate drone use. With the improvement of drone technology, the cost of drones will decrease. Furthermore, advances in technology such as battery capacity and payload weight reduction are projected to boost flying time and range. These developments will ensure that farmers get more benefits from the use of drones in agriculture.

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DISINFECTION IN AQUATIC INDUSTRY

Arzoo Khan[1*] and Shivam Pandey[2]
[1]Dept. Of Aquaculture, College of Fisheries
GBPUAT, Pantnagar (Uttarakhand)
[2]Dept. of Aquatic Animal Health Management
College of Fisheries, CCSHAU, Hisar (Haryana)
*Corresponding Author :- arzookhan786jbp@gmail.com

Abstract
Different types of disinfections has to be done in all possible ways to completely avoid the infection in fisheries sector. In this process, a variety of hatchery system components is subjected to disinfection, like equipments such as pipes, tanks, bio-filters, nets, floor, boots, culture water, input water, food, stock and air, output of effluent, debris and dead fish etc. Disinfection has widespread application as a method of sanitation, to eliminate or suppress the presence of the initial infective unit that is the pathogen.

Introduction
During the routine operation in hatchery, many pathogenic microbes may accumulate in the equipment and components of hatchery system. When there is any drastic change in water quality favouring the microbes, it will enhance in number and prone to cause disease to culture organisms. The best method to avoid the infection is the breaking of life cycle or continuity of such pathogens in the hatchery. For this, the hatchery should be disinfected and shut down between production cycles so that the pathogens will have no host to infect and will get eliminated from the system. This is to ensure non-settlement of microbes in the system. An important part of bio-security measures in an ornamental aquatic facility is disinfection. Chemicals are not always necessary sometimes other methods are just as good or even better.

Importance
- Disinfectants are used to kill or eliminate microorganisms and inactivate virus on inanimate objects and surfaces (devices, instruments, equipments, walls, floors, ponds, tanks etc).
- Helps to avoid disease appearance and spread in aqua-hatcheries, ponds and nurseries.
- Diseased aquatic animals, animal fluids and tissues (viscera, blood, mucus, faeces) and their contact with equipment and workers present a risk of transmission of pathogens could be reduced by using specific disinfectants.

Methods of Disinfection
Disinfection is broadly classified in two methods :

Physical Methods of Disinfection

Cleaning : Cleaning removes harmful organisms. It is mainly used in equipment disinfection. The tanks and other equipments are scrubbed with brushes or scrub pads of various designs. This can be enhanced by using standard detergent powders to inactivate the organism even if they cannot be removed.

Wet washing : A first step in disinfecting for most materials or equipment to be disinfected is wet washing with soap or a detergent. Soaps and detergents are very effective disinfectants. Wet washing with warm water, over 35°C with soap or a detergent is effective in removingand destroying infectious particles, removing over 99% of the pathogens.

Heating : Heating is a common method of disinfection that will help in eliminating the microbial load in any system or component. The temperature above certain level would kill the microbes by dehydration of the cells. Heat exchangers of the hatchery systems increase the water temperature to a level that is intolerable to some microbial pathogens. Heating of water is suitable only for smaller systems. Since many years some facilities work with water boilers. They use this boiler to disinfect nets used in holding facility. The water is continuously kept at temperature of 100°C, enough to kill all possible pathogens on the nets. The only disadvantage of this system is that the personnel should be careful not to get burned. The method however is very effective for disinfecting dip nets.

Sunlight : Direct sunlight is also a very efficient disinfecting method. A disadvantage however is the time needed to reach disinfection. The infra-red component as well as the visible and theultraviolet component of light contribute to the disinfection. The efficiency depends on the intensity of the light but also on the cleanliness of the material to be disinfected. On the low tech end of our industry sunlight is used to disinfect nets, tanks and even ponds. Everything what needs to be disinfected first needs to be thoroughly cleaned and then completely dried.

Filtration : This is the physical removal of debris and other solid materials that are present in suspension. This is mainly used to remove solids from supply water. Removal of solid particles also helps in the reduction of microbial load associated with those solids in suspension. This filtration is effected by designed filters and filter materials that are non-toxic and non-corrosive. There are physical filters and biological filters with the application biological principles such as nitrification for removal of ammonia in the rearing water. It can be said that a perfectly designed biological filter will keep the water free from ammonia and mortality due to ammonia.

Dehydration : Dehydration or drying and reducing water contact of equipments or entire system provide a degree of disinfection. Drying easily destroys fragile stages of many parasites and dry surface have greater exposure to the effects of UV light.

Radiation

UV light

The UV light of approximately 2500 to 2650 Å wavelength effectively destroys vegetativestages of many, pathogens such as virus, bacteria and fungi. During water disinfection by radiation, pretreatment such as sedimentation and filtration make the water suitable for UV radiation treatment, by removing the hurdles for penetration of UV light. The UV raysare used to disinfect the organisms in limited dose. The dosage depends on intensity of light, duration of UV light on organisms. Ultraviolet filtration, in short UV is present in sunlight and in mercury vapor lamps. It disinfects by destroying the DNA of biological material in the case of pathogens, the DNA structure of the pathogens is damaged and the pathogen kills large particles present in the water to be filtered by UV will absorb largeparts of the light and will make the use of UV light less efficient.

Gamma radiation

Gamma radiation is a beam of very high energy photons with a very high capacity to penetrate. It

is used for disinfection of laboratory equipment but also in the food industryto kill bacteria, fungi and parasites and prolong the shelf-life of food products. It is an excellent way for disinfecting e.g. frozen and dry foods to assure the industry operators that they purchase bio-secure food for their fish. Unfortunately, gamma radiation does not kill viruses.

Chemical Methods of Disinfection

There are a wide variety of chemicals available for disinfecting of which a limited numberis used in aquaculture.

Acids

The character of an acid is the presence of a hydrogen ion (H^+) in a water based solution. This hydrogen ion inhibits the duplication in the pH range of 3-6 and kills bacteria and unenveloped viruses like SVC and KHV) at pH below 3. This does not apply to Mycobacterium sp. (fish tuberculosis) and some spores of bacteria Several mineral acids have proven to be effective disinfectants like Citric and Acetic acid.

Alkalis

The effective part of alkalis is the hydroxyl ion (OH^-) which inhibits effectiveness or kills most bacteria and enveloped viruses at pH above 9. It is again effective against enveloped viruses (like SVC and KHV) and bacterial spores. Especially sodium hydroxide or caustic soda, is an often used disinfectant. Calcium hydroxide, slaked lime, is used in aquaculture and has proven reasonably effective against non-forming bacteria.

Chlorination

It is commonly used method of disinfection of water in hatcheries. The water is treated with 0.2 to 0.5 mg Cl_2/L of water for 20-30 minutes. The removal of residual chlorine priorto introducing the disinfected water into hatchery is inevitable. Vigorous aeration was given to remove the residual chlorine present in water or it is passed over charcoal for removal of chlorine. If any chlorine residue is present in treated water, it is toxic to fishes. Chlorine in the form of calcium and sodium hypo-chlorites and chloramines are commonly used. Nowadays chlorine dioxide is also used as disinfectant, which is considered safe as it seldom leaves any residual chlorine in harmful form.

Ozonation

Electric discharge and UV radiation of a suitable wavelength produce a 3 atom form of oxygen (ozone). The contact concentration of ozone is around 3 mg/L of water with residuals of below 0.15 mg/L. The residual ozone may also be removed with charcoal priorto use. However the cost of equipment and use are relatively high.

Formalin and formaldehyde

Formalin water containing dissolved formaldehyde is a readily available industrial chemical. A 1:100 mixture of formalin and water is used to disinfect the water. Formaldehyde (HCHO) gas has been used for the disinfection of sealed building, usually generated by heating Para formaldehyde and the polymerized solid of formaldehyde. It iseffective against many viruses and bacteria.

Quaternary ammonium compounds (QAC)

QAC are widely available in numerous brands and strengths. The active concentration is approximately 1200 mg/L (1200 ppm) of water. It is effective against Gram positive bacteria and some viruses but less effective against fungi and Gram-negative bacteria.

Hydrogen peroxide

It is clear colorless, water like in appearance, has pungent odour, and is not highly corrosive and does not have dangerous effect. H_2S as a disinfectant in a concentration of3% gives good results in aquaculture and in the aquarium industry. It is again the active oxygen radical which is effective compound.

Lime

The process of liming is considered an integral part of pond management. These include improvement of soil chemistry like decreasing soil acidity, increasing total alkalinity, neutralizing sulfides and acids, precipitating suspended organic material, decreasing BOD and improving nitrification. There are various categories of lime that are used in grow-outponds, most common is agricultural lime ($CaCO_3$).To disinfect, 100-300kg/ha is applied in fish ponds during the culture period.

Iodophores

Iodophores are usually available at 1% solution. They are organic compounds that release free iodine. The active concentration for disinfection of water is 50 mg/L and for equipments 250mg/L. It effectively disinfects bacteria and some viruses.

Conclusion

Disinfection procedures when properly applied can ensure safe use of instruments and devices. Many disinfectants are used in aquaculture facilities which include chlorine, hypo-chlorites, BKC, formaldehyde, hydrogen peroxide, Iodophores quaternary ammonium compounds etc. The most efficient way to protect the aquaculture facility from microorganisms that have the potential to create a devastating economical impact, are to merge the bio-security program with appropriate disinfectants that helps to safeguardthe aquaculture unit. The concentrations of the disinfectants should be applied appropriately otherwise it can cause adverse effects to the organisms living in it i.e. may be fatal to fish and shellfish and induces toxicity.

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ADOPTION AND IMPACT OF ZERO TILLAGE IN THE RICE-WHEAT PRODUCTION SYSTEM IN INDO-GANGETIC PLAINS

Sukanya Barua, Rajeev Kumar, V. Sangeetha,
L. Muralikrishnan, Anirban Mukherjee and Shubhasree Sahoo
Corrosponding e-mail: Sukanya.iari@gmail.com

Conservation Agriculture (CA) is an approach for development and management of natural, sustainable and resource saving agricultural systems. It means to protect, improve and develop much optimum utilization of natural resources by integrated management of crop, soil, water and many biological resources with selected external inputs. Such a technological package represents a resource saving and efficient agriculture which contributes significantly to environmental conservation and also enhances production on a sustainable basis. Zero tillage is a promising conservation agriculture technology which can be described as the procedure where the seed used to sown through driller without any land preparation and disturbing the soil environment where previous crop stubbles are present. It not only diminish cost of cultivation but also reduces the irrigation requirement, soil erosion, crop duration and weed effect which is better than tillage. Zero Tillage (ZT) also known as No Tillage or Nil Tillage.

History

Zero Tillage method of farming started from 1960s by Indian farmers. The system is being followed in the Indo-Gangetic plains where rice-wheat cropping system is present. Wheat used to plant after paddy harvesting without any tillage operation. With following the same system many farmers of the region getting more production and profits by reducing the cost of cultivation. Southern districts like Guntur and some parts of West Godavari of Andhra Pradesh state follow the ZT system in rice-maize cropping system (Tripathy *et al.*2013).

The green revolution smoothens the way for the rice-wheat production system in Indo-gangetic plains of India. But with passing of time, the productivity of rice and wheat become sluggish due to inappropriate nutrient, soil and water management system and late planting of wheat, because in the hot season rice is being grown and in the winter wheat follows the rice (Raju *et al.* 2014, Moscona J.2017), So during 1990's the zero tillage become popular among farmers to mitigate problem, by sowing the wheat by drilling without any tillage and land preparation.

The success of no tillage depends on the machinery to drill seed in the undulated land. During 1980's, CIMMYT developed a prototype for drilling the seed (Uehara, 2006). In India first seed drill was manufactured by GB Pant University with a motor with the main objective to reduce the cost and make it to affordable to majority of farming community. The drills are tractor driven and used mainly in rice-wheat cropping system.

Zero tillage already proves beneficial for direct sown rice, cotton, maize, soybean, mungbean, pigeonpea, clusterbean, pearlmillet during kharif season and wheat, barley, chickpea, mustard and lentil during rabi season. Wheat sowing after rice advanced by 10-12 days after adoption of this technique as compared to conventionally tilled wheat, which results in reduction in wheat yield and late sowing also can be avoided. In this way ZT facilitates wheat crop to escape from terminal heat stress. Zero tillage reduces cost of cultivation by nearly Rs. 3000-3,500/ha through

reduction in cost of land preparation and reduces diesel consumption by 50-60 litres per hectare (Hussain, A, 2012) . This technology also reduces irrigation requirement of crop and the loss of organic carbon by oxidation. Zero tillage reduces weed problem like Phalaris minor in wheat. The organic carbon status of soil is also significantly increased in surface soil (0-5 cm), particularly under crop residue retention with zero tillage *(*Policy paper 31 - Doubling Strategy for Doubling Income of Farmers in India).

Impact of zero tillage

The adoption and diffusion of the zero tillage technology increased in the past decade, particularly in Indo-Gangetic Plains (IGP) of India. During 2008 zero tillage area in India estimated to be 1.76 million hectares and used by 620,000 farmers (IFPRI discussion paper, 2009).

It results in drastic reduction in tillage intensity which results in significant cost savings as well as potential gains in wheat yield through earlier planting. Wheat farmers who practiced zero tillage could increase their farm income by about 7150 INR per hectare (IFPRI discussion paper, 2009). The impact on reduced cost of cultivation alone makes zero tillage profitable and is the main reason behind its huge success.

The amount and type of actual environmental benefits of 'no tillage' have yet to be fully analyzed and imply tackling the challenge of reducing tillage for the rice crop which follows wheat and retaining previous crop residues as mulch, and diversification of crops. A major part of farmers in Indo-Gangetic Plains have already adopted zero tillage because it provides immediate, visible and demonstrable monetary advantages such as less production costs and timely sown crops which ultimately gives enhanced crop yields (Erenstein and Laxmi, 2008) . On the other side though the technology results in gaining benefits in many folds but the recent diffusion of zero tillage to farmers especially small and marginal farmers experienced difficulty in following the wider tenets of precision farming, particularly year-round tillage reduction, crop residue retention, and crop rotation.

Still, zero tillage is not universal option and need complementary technologies that are socially and economically attractive. On the same time, technological change can only go so far and needs to be complemented with institutional change to create the necessary incentives to induce change and to align private and social interests.

Despite the wide adoption of zero tillage in Indo-gangetic area, there is still significant gap in knowledge. Particularly scarce resources are reliable and empirically based on zero-tillage diffusion indicators and also documented the evidence of zero tillage's socioeconomic, livelihood, and environmental impacts. Addressing these knowledge gaps would considerably increase our understanding of the sustainability implications and remaining challenges. A better knowledge of livelihood implications and stakeholder participation would increase the ability to keep interventions "pro-poor" and need-based.

Adoption and Economics of Zero Tillage Wheat

Adoption of zero tillage wheat presented in Table 1 which represents the adoption trends of ZT technology in the sample villages. As the sample includes only those five villages namely Jahari, Sandel kila, Sandel khurd, Sahejadpur and Jagdishpur where this technology is relatively popular in Haryana, very high awareness as well as adoption rate (78%) were observed. This take-off point of

zero tillage technology occurred during the 2005–06 in wheat season, which coincides with the time of getting high extension inputs by rice-wheat consortium of CGIAR which promoted conservation agriculture in the Indo-Gangetic Plains. Adoption is higher among the large farmers compared to the small and marginal farmers, but the difference was found to be statistically insignificant. Dis-adoption rate is much lower than in many other villages. There is significant difference regarding input use between adopters and non-adopters of zero tillage technology (Table 2). It was observed that drill use reduces seed quantity, while there is a marginal increase in chemical fertilizers in the 'no tillage' plots. The most significant cost changes are observed in labour charges. Adopting technology spares about 69 per cent of hired human labour and 22 per cent of machine labour which as a result lowers the total cost of cultivation by 28 per cent over conventional wheat plots and by 27 per cent when the family labour component is imputed. Singh and Meena (2013) also found similar trend of results in their study. The comparison of cost of cultivation and profit of zero tillage and conventional tillage is given below:

Table 1: Adoption pattern of zero tillage Wheat technology in Haryana n=150

Farmer Class	No. of observations	No information	Only heard	Heard & Seen	Adoption and continued	Disadoption
Small	50	0	0	18.5	79.0	2.5
Large	50	0	0	12.0	84.0	4.0
Medium	50	0	0	20.0	77.0	3.0

Table 2: Impact of zero tillage (With-Without study) n=150

	Zero Tillage (N=150)			Conventional Tillage (N=150)			Per cent difference between ZT and CT
Cost(Rs./ha)	Mean	Minimum	Maximum	Mean	Minimum	Maximum	
Seed	2035.6	1104.8	2790.8	2200	1180	2904	7.5
Farm yard manure	130.8	0	1710.0	145.0	0	1780	10.34
Chemical fertilizers	3745.0	2080	3945	3493	2145	3842	6.73
Plant protection chemicals	1500	523	3267	2234.8	1932	3270	-32.85
Hired Human Labour	1537	0	18329	4972	0	25203	-69.08
Machine labour cost	5037	500	7012	6920	752.9	10235.9	-27.21
Imputed cost of family labour	6250	2450	2450	6790	0	32541`	-7.95
Wheat Yield (Quintals/ha)	51.3	30.1	57.8	48.5	28.8	55.9	4.84
Net revenue (including family labour cost)	39371.2	12290	45700	30346.2	5453.8	35321.6	-13.84
	4.1			2.5			

Adopting ZT is associated with 4.84 per cent increase in yield as compared to conventional tillage while decrease in cost of cultivation significantly. It also results in 13.84 per cent increase in profitability including family labour cost for the analysis (Table 2).

Conclusion

The natural resources are scarce and degrading day by day with exploitation of huge population pressure. Zero tillage is one of the very potential technologies in this scenario. It has drawback of more use of non selective herbicide, but still has more benefits than the conventional cultivation. Zero tillage helps in fetching of enhanced profit and timely harvesting of crops with increased yield. So it ultimately helps to enhance farm income.

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GERANIUM PRODUCTION POTENTIAL IN INDIA

Sharad S. Jadhav[*1] and Pratiksha J. Karpe[2]
[1]Ph.D. Research Scholar, PGI, MPKV, Rahuri (MS).
[2]MSc. Scholar, College of Agriculture, Latur (MS).

Geranium is a highly adaptable, drought tolerant, perennial aromatic herb cultivated under varied agroclimatic conditions in India. Geranium oil obtained by steam distilling the fresh biomass has a variety of uses in high grade perfumery. India produces about 20 tonnes geranium oil every year and imports another 20 tonnes for internal consumption. Therefore, there is a need to increase the domestic production of geranium oil.

Efficient cultivation practices are being developed at Nilgiris, Palani Hills, and Plains Bangalore and Hyderabad by Central Institute of Medicinal and Aromatic Plants, Hyderabad in order to increase the yield levels of geranium oil. A new species of geranium has been recently introduced at CIMAP Regional Centre, Bangalore which has been found to be relatively more resistance to Fusarium wilt which is major constraint in geranium production.

The cultivation of geranium in the plains offer scope for extension of cultivation of the crop in new areas of the plains. It can safely be said that higher elevations are not a prerequisite for cultivation of geranium crop.

In India, a variety of geranium types are available with a various range of geraniol and citronellol contents in the oil therefore very high demand for geranium oil. Geranium oil is widely used in the soap, perfumery, and cosmetic industries. The oil is described to have a fine rosy odour with pronounced fruity minty undertone and a rich long lasting, sweet rosy dry out. The oil is commercially produced in China (50 tonnes). Egypt (40 tomes), Morocco (15 tonnes), Russia (10 tonnes), Algeria (10 tonnes), India (5 tonnes) and Israel (1 tonne).

The production of geranium oil in the country is about 20 tonnes and about 20 tonnes of oil is imported to India every year. The imports during the last ten years have increased from a level of less than 8 tonnes to the present level of about 20 tonnes, despite increased production of the oil within the country. Accordingly, a minimum of 20 tonnes more of geranium oil has to be produced in the country to meet the immediate requirements of the industries.

Soil : Geranium thrives in well drained soils. The soils which are either saline or alkaline with poor drainage are unsuitable for its cultivation.

Climate : The crop well grows in mild climate with low humidity, warm winter and mild summers having annual rainfall ranging 100 to 150 cm. It is found growing successfully from an altitude of 1000 to 2100 m.

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Geranium Plant

Geranium Cultivation

Planting Material

- To propagate geranium, terminal cuttings of 20 cm length consisting of about eight nodes are taken from healthy plants. Except for the first 3-4 leaves from the top the rest are trimmed. A slant cut is made with a sharp knife just below 6th to 7th node and dipped in 0.1%, Benomyl solution for 10 to 20 seconds.
- They are then planted in the nursery beds at 5 cm spacing. Beds are provided with proper shade and watered twice daily for about 3-4 days and once in a day, subsequently. November to January months is best suited for raising the nursery.
- The cuttings will be ready for transplanting in about 2 months from planting. Under mist conditions however, the rooting of cuttings can be accomplished within about 20 days.
- For transplanting, the rooted cuttings are carefully dug out from the nursery, dipped in 0.1% Benomyl solution and transplanted immediately.

Geranium seedlings

Planting

It is recommended to plant geranium in the winter months in December or January. Transplanting done at 60 x 60 cm spacing, 27,777 Seedlings/ha or 60 x 45 cm spacing.

The returns from geranium cultivation can be increased by intercropping pulse crops such as cow pea or black gram in the early stage of geranium growth which gives extra income.

Nutrient Management : Apply 10 t FYM/ha. Before planting. Recommended dose of fertilizer for geranium is 200:35:35 NPK kg/ha. Full dose of phosphorus and potassium apply as basal dose at the time of planting and Nitrogen is applied in 6 equal split doses. The first dose is given as basal dose and thereafter at bi-monthly intervals. Secondary nutrients and micronutrient are applied as soil test recommendations.

Plant Protection:

1) Major Insects : Termites

Management : Termites can be easily controlled by mixing into the soil 25 kg/ha Heptachlor and irrigating the field.

2) Major Disease : Wilt

The main problem encountered in the production of geranium is high susceptibility of the crop to vascular wilt caused by *Fusarium oxysporum* var. rodolens, a soil borne fungus which results in heavy yield losses in some seasons.

Management

Minimum irrigation and proper hoeing ensure healthy growth. Over watering increases the incidence the incidence of wilt. Sharp sickles are used for harvesting to avoid jerks and pulls. Any damage to the stem near the ground may pave the way for infection.

Spraying of 0.2% Benomyl two weeks before the harvest. After the harvest, treat the cut ends with the fungicide and repeat the spray after two weeks.

Harvesting and Yield

The crop is ready for harvest after about 4 months of transplanting. When the leaves begin to turn light green and exhibit a change from lemon like odour to that of rose. The green leafy shoots are harvested with a sharp sickle and taken for distillation immediately. The crop is perennial and can give good harvests for about 3-6 years. A total of three harvests in a year can be obtained.

The yield of fresh herbage per hectare per year from all the three harvests may be about 15 tonnes per hectare which on distillation may yield about 18 kg of oil.

Drying Method

The harvested material is spread out under shade in thin layers & is turned periodically to ensure proper drying. For higher recovery and good quality of oil, the moisture content of herbage must be between 8 to 10%. Drying normally requires 3 to 6 days. Properly dried leaves increase characteristic patchouli aroma, which is less noticeable in fresh leaves.

Oil Extraction

The Geranium leaves and stalks are used for extraction, and the oil is obtained through steam distillation. Steam distillation is the best process which gives better quality oil. Distillation takes 3 to 4 hours. Steam Distillation is the most popular method used to extract and isolate essential oils from plants for use in natural products. This happens when the steam vaporizes the plant material's volatile compounds, which eventually go through a condensation and collection process. The steam distillation process works on the principle that when a mixture of two or more undissolved liquids is heated.

Oil Extraction Unit

While ensuring that the surfaces of both liquids are in contact with the atmosphere, the vapor pressure exerted by the structure increases. The oil is extracted from the whole plant using a distillation unit consisting of a distillation tank, a condenser, and a separator. Freshly harvested Geranium grass as such or after cutting into small pieces is loaded into the distillation tank. After closing the lid tightly, steam is passed into the distillation tank. A large container called a Still,

which is generally made of stainless steel, containing the plant material has steam added to it. Through an inlet, steam is injected through the plant material containing the desired oils, releasing the plant's aromatic molecules & turning them into vapor. The vaporized plant compounds go to the condensation flask or the Condenser. Here, two separate pipes make it possible for hot water to exit & for cold water to enter the Condenser. This process makes the vapor cool back into liquid form.

Geranium Oil

Geranium oil produced in the country is well accepted by the perfumery industry. The citronellol and geraniol contents in the oil produced in India are very much comparable to those produced in other parts of the world. The oil from the strain newly introduced in Bangalore is found to be rich in geraniol and low in citronellol which is different from all the other oils, produced in India or elsewhere. Now variety of geranium types in the country with varying proportions of citronellol and geraniol. This should provide wider scope for the producer to select a geranium oil with a particular combination of citronellol and geraniol of his choice to create specific odour value in his perfumery compositions.

Geranium Oil

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GREENHOUSES: A CENTRE FOR PROTECTED CULTIVATION AND SMART AGRICULTURE

Saipayan Ghosh*, Vivek Kumar Patel and Ankit Singh*****
*Department of Horticulture, PGCA, RPCAU, Pusa, Samastipur, Bihar, 848125
**Department of Plant Pathology, PGCA, RPCAU, Pusa, Samastipur, Bihar, 848125
***Department of Agronomy, PGCA, RPCAU, Pusa, Samastipur, Bihar, 848125
****Corresponding author**: vivek10995@gmail.com

Abstract
A greenhouse is a system for modification and management of environmental factors that allows plants to be grown in suitable climates that may be not well suited for their growth and development. This greenhouse technology gains significance in changing climatic scenario which emphasizes on high quality production along with higher productivity by efficient utilization of available resources. However, the productivity and efficiency of green house technology is fully depends on the types of greenhouse structure used for production. The recent trend in growth of the human population, along with the advancement of consumption patterns, emphasizes the development of innovative greenhouse structures. The efficiency and productivity of a greenhouse operation is largely dependent on the type of growing structure used. Therefore, it is very essential to become intimate with the advantages and disadvantages of each green house types and structure.

Keywords : development, greenhouse, production, technology

Introduction

In this technological development, greenhouse technology has got a lot of popularity over the years. It is a framed or covered structure with a transparent or translucent material which permits ample sunlight for crop production and has provisions for at least partial control of plant environment. This technology of using greenhouses to grow plants is of significant importance, especially in areas where the climatic conditions are always on the extreme side and regions of high rainfall. For this various types of greenhouse structures are available for crop production.

A. Types of Greenhouses

1. Based on cost investment

I. Low technology greenhouses

The size of the low technology greenhouses is less than 3 metres in total height. The most common type low technology greenhouses involve tunnel houses provide poor ventilation as they do not have vertical walls. Low technology greenhouses generally provide suboptimal growing environment which results yield reduction and little reduction in the incidence of pests and diseases however, low technology greenhouses offer a cost effective entry to the farming industry.

II. Medium technology greenhouses

The size of the medium technology greenhouses is more than 2m but less than 4 metres tall and a total height usually less than 5.5 metres. They also provide medium automation and usually use clad with either single or double skin plastic film or glass. Medium level

greenhouses offer a compromise between cost and productivity and represent a reasonable economic and environmental basis for the farming industry. There is greater opportunity to use non-chemical pest and disease management strategies but overall the full potential of greenhouse horticulture is difficult to attain.

III. High level greenhouses

Height of high level greenhouses wall is at least 4 metres and height of roof peak is upto 8 metres above ground level. Cladding materials used in high level greenhouse are plastic film (single or double), polycarbonate sheeting or glass. There is an automation environmental control. These structures offer enormous opportunities for economic and environmental sustainability. Although these greenhouses are capital intensive, they offer a highly productive, environmentally sustainable opportunity for an advanced fresh produce industry. Investment decisions should, wherever possible, look to install high technology greenhouses.

2. Based on shape

I. Lean-to type greenhouse

A lean-to type of greenhouse is applicable when it placed against the side of an existing greenhouse structure for one or more of its sides. The whole structure should face south side which is the best direction for adequate sun exposure. This type of greenhouse is limited to single or double-row plant benches with a total width of 7 to 12 feet and length can be as the building it is attached to the structure.

Advantages

a. Least expensive structure which close to available electricity, water and heat source.
b. Makes the best use of sunlight and minimizes the requirement of roof supports.

Disadvantages

a. Limited space
b. Limited light
c. Limited ventilation
d. Temperature control

II. Even span type greenhouse

The even span is the common type of greenhouse constructed fully on ground level with the two equal width and pitch of roof slopes. This type of greenhouse is restricted to 2 or 3 rows of plant benches. Due to the size of greenhouse structure and substantial amount of uncover glass area, it will cost more to heat. It accommodates two side benches, two walks and a wide centre bench. For single span type the span in general, varies from 5 to 9 m, whereas the length is around 24 m and the height varies from 2.5 to 4.3 m.

III. Uneven span type greenhouse

This uneven span type of greenhouse is suitable for hilly or undulating terrains. The roofs of the structure are differ in width; which resembles the name of the structure and make the structures adaptable to the side slopes of hill.

IV. Ridge and furrow type greenhouse

This type of greenhouse designs use two or more A-frame greenhouse structure connected to one another along the length of the eave. The eave represent as gutter or furrow to handle rain water

and melted snow. The interior space in greenhouse structure reduces labour, minimize the price of automation, upgrade personal management and less consumption of fuel as there is less uncovered wall area through which heat escapes.

V. Saw tooth type greenhouse

This type of greenhouses is similar to ridge and furrow types, except that this type provides natural ventilation from saw- tooth form of the greenhouse. The roof ventilation alone provides 25% of the total ventilation of the covered area, in addition to the side ventilation. The shape of the arches allows excellent light transmission.

3. Based on utility

I. Active heating system of greenhouses

The air temperature within the greenhouse drops at night. To keep plants from getting a chilly bite from freezing, some heat must be provided. The amount of energy required to heat a greenhouse is determined by the rate at which heat is lost to the outside environment.

II. Active cooling system of greenhouses

For optimum crop development throughout the summer, it is preferable to keep greenhouse temperatures lower than ambient temperatures. Evaporative cooling pads with fans or fog cooling are used in this style of greenhouse. This greenhouse is built in such a way that it allows for a roof opening of up to 40%, and in some circumstances up to 100%.

4. Based on construction

I. Wooden framed structures

Wooden frame structures are applicable where greenhouses with span is less than 6 m. Pine wood 4 is commonly used as it is inexpensive and possesses good strength. Similarly, locally available timber can be used for the construction of greenhouse as they are good in strength, durability and machinability.

II. Pipe framed structures

Pipes are used for construction of greenhouses, when the clear span is around 12m. In general, the side posts, columns, cross ties and purlins are constructed using pipes.

III. Truss framed structures

Green house structures can be made in truss frames, if the span is greater than or equal to 15m. Flat steel, tubular steel or angular iron is welded together to form a truss encompassing rafters, chords and struts. Struts are support members under compression and chords are support members under tension. Angle iron purlins running along the length of greenhouse are bolted to each truss.

5. Based on covering materials

I. Glass greenhouses

Glass is used as covering material in glass greenhouses. As a covering material it has the advantage of greater interior light intensity, have higher air infiltration rate, and leads to lower interior humidity and excellent disease prevention quality.

II. Plastic film greenhouses

The covering materials of flexible plastic films including polyvinyl chloride, polyethylene and polyester are used in this type of greenhouses. As a covering material for greenhouses, plastics are more popular, cheap and the less heating cost as compared to glass greenhouses.

III. Rigid panel greenhouses

Quonset type frame is also known ridge and furrow type frame material in which polyvinyl chloride rigid panels, fibre glass-reinforced plastic, acrylic and polycarbonate rigid panels are used as the covering material in greenhouse. These material provide more uniform light intensity throughout the greenhouse and also resistant to breakage than plastic or glass.

B. Components of a greenhouse structure

1. Framing Materials

Aluminum, steel and wood framing materials are popularly used for construction of greenhouse. However, out of these three, aluminum is the most durable and economical.

2. Covering Materials

Greenhouse covering materials should be clear enough to provide optimum light transmission and long lasting as well as inexpensive. Glass materials are good for best light transmission for greenhouse crop production but the structural components bused to support glass are very costly. Another covering material fiberglass is more long lasting and does not need the substantial structural components as required in glass house. Double sheets of polyethylene (PE) film, filled with air, is one of the most popular non rigid covering materials on traded greenhouses, give support required for normal operation.

Conclusion

The design of greenhouse construction affects the productivity as well as efficiency. The productivity and efficiency of greenhouse is highly affected by its design. Ridge and furrow design of greenhouse provide the substantial productivity and efficiency in production and most reliable and popularly used framing material for trading greenhouse structures showed aluminium material. Similarly, double sheets of polyethylene film are the most inexpensive covering material available for crop production. However, the initial and long standing costs of the facility, non availability of various structural components, non standardization of region based greenhouse and other structures design and lack of awareness are major limiting factors in the adoption of this technology.

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TECHNIQUES TO BE FOLLOW IN THE SILK INDUSTRY WHILE USING CHEMICALS

Akkabathula Nithish
Assistant Professor (Agri. Entomology)
nitishakkabattula@gmail.com
SKLTSHU, Telangana

In India, silkworm rearing is also considered as a key factor in the activities that financially support the poor and middle class farmers. Farmers use a variety of chemicals in silkworm rearing. These help them a lot in producing fine quality silks. However, not only the farmers but also many lower level technicians have a limited knowledge on these chemicals. So there is a lot that everyone who is raring the silkworms need to know about them.

1. Formalin

Formalin is water-soluble formaldehyde. It acts as an antiseptic solution that kills germs. It absorbs fluid and water from the germs and kills them.

Method of use

Formalin can be used to disinfect silkworm breeding rooms and other equipment. The formalin is available in the market has 36-40% formaldehyde concentration. Two percent formaldehyde solution can act as a good antiseptic solution. If the humidity in the atmosphere is above 70 and the temperature is 20 degrees centigrade, at least 30 minutes of chemical reaction can kill the germs. Effective disinfection can be achieved either by spraying formalin solution directly on the germs or by smoking formalin liquid in an airtight room as fumigation.

Precautions

- Formalin is a carcinogen. Therefore care should be taken not to spill the solution on body parts especially on the skin, eyes and nose.
- Raincoat and mask must be worn while spraying the solution.
- Disinfection with this formalin solution gives good results. But formalin should not be used in areas where the temperature is less than 20^0 C such as huts, airtight rooms, living quarters or livestock barns.
- Reliable and quality formalin is available at silkworm chemical stores, silk egg manufacturing centers, state and central silk industry offices and serifed offices.

2. Bleaching powder

It is a white lime powder with a chlorine odor. It is used as a prophylactic in silkworm rearing. Chlorine in bleaching powder denatures the proteins in germs and kills them.

Method of use:

Bleaching powder usually contains 30% activated chloride and 10% solution can kill bacteria, viruses and other pathogens. Rooms and other equipment can be cleaned using 5% bleaching powder solution. Lime powder containing 10% bleaching powder can be used to clean the silkworm breeding room and surrounding areas. Concrete floors in the rearing room can be wiped clean with a 2% bleaching solution. 0.6 to 1 % solution can be used for hand washing. 50g of bleaching powder is added to one liter of solution to make 5% solution.100 g of bleaching powder can be mixed with 900 g of lime to make 10% bleaching lime powder. 400 ml solution per square meter area or 2.5 liters of solution per square meter floor is required.

Precautions

- Chlorine in bleaching powder is easily absorbed into the atmosphere so care should be taken to keep the powder in airtight containers.
- Bleaching powder eats away at flakes and iron objects. Therefore rearing stands and other objects made of iron should be cleaned with clean water after 30 minutes of using bleaching powder.

3. Vijetha

The powder that cleans silkworm beds is available under the name “Vijetha”. It prevents many fungal diseases in silkworms. It can be used for effectively control many diseases caused by fungi and viruses in silkworms.

Method of use

Sprinkle the powder evenly at the rate of 3 grams per square foot (for first to third instar worms) and 5 grams (for fourth and fifth instar worms).

Spray the powder after cleaning the stands and rearing equipment. Mulberry leaves should be feed to the worms at least 30 minutes after the powder has sprayed.

Precautions

- The powder should not be used when the worms are in fever.
- Care should be taken that the powder should not fall on mulberry leaves while feeding.
- Sprinkle the powder only after cleaning the beds.
- Care should be taken not to let the powder fall on the body parts such as mouth, eyes and nose.
- Buy only powder made by the 'Vetcare' company approved by the Central Silk Board.

4. Fungicides

Fungicides such as Dithane M-45 and Captain can prevent 'Mascardine', a fungal infection of silkworms.

Method of use

Any fungicide can be applied in a ratio of 1-2%. The desired percentage is 10 grams of fungicide powder, and 20 grams of powder, 990 grams. Add kaolin or lime powder and sprinkle on the silkworms. Sprinkle 35 grams of powder on worms in fever, in equal proportions on each square foot area on the fourth day after rising from the fever.

Precautions

- Fungicides should be kept away from worms, i.e. mulberry leaves should not fall on it.
- When spraying, it is necessary to take care not to touch the body parts especially the mouth, eyes and nose.

5. Slaked lime (calcium hydroxide)

It is used to clean beds. It prevents viral and fungal infections. This slaked lime is formed by chilling and drying water on well-baked lime.

Method of use

Sprinkle this powder before the silkworms go into fever. Sprinkle around the worm body so that it evenly spreads all over the body.

Precautions:

- Care should be taken that slaked lime powder should not be eaten by worms.

- Do not inhale this powder while using.
- The powder available in the market should be moisture free.

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CHALLENGES FACED BY DAIRY SECTOR IN NORTH EASTERN STATES

Saroj Rai*, Ashis Debbarma, Dilip Kumar Mandal and Rani Alex[1]
ICAR-National Dairy Research Institute, Eastern Regional Station
Kalyani, West Bengal
[1]ICAR-National Dairy Research Institute, Karnal, Haryana
***Corresponding Author : drsaroj.rai@gmail.com**

Dairy sector in North Eastern (NE) states of India is still in its nascent stage. With rapid urbanization and booming human population, there is scarcity of feeds and fodders. The contribution to the country's total share in milk production is almost negligible from the NE region except Assam which accounts for only 0.46 % of total share. The North Eastern States of India comprise covers 25.509 M ha, which is about 8% of country's geographical area. More than 64 % of the total geographical area is covered by thick green forest. Except the Brahmaputra valley covers about 30 % land, the rest is hilly and mountainous track with steep slopes (Baruah et al., 2014). The huge gap between demand and supply of fodder is major felt especially in the summer months while shortage of concentrates is around 75 per cent (Gupta, 2007).

Challenges

Fragmented land holding : Around 85 percent of the operational holdings in the country are small and marginal, i.e., that is holdings of less than 2 hectares each It is estimated that the average size of land holding, which at present is 1.15 hectare, is likely to reduce further by 2020-21 (State of Indian Agriculture, 2015-16). Further North Eastern states accounts for 0.60 to 1.00 ha size of operational land holding. Increasing fragmentation of land holdings is a continuing cause for concern as over use of the land without scientific knowledge on crop rotation has diminished the

soil fertility merely sustaining their immediate needs. Small land holdings have also resulted in inefficient adoption of mechanization so manual means of post harvest techniques results in low value for the produce.

Feed deficit : Most of the dairy farmers are small holders having one or two local milch cattle sustaining on crop residues and by-products or browsed on common property. Feeding nutritious feeds and fodder are generally restricted only to some crossbred cattle. Lack of suitable infrastructure i.e. warehouses, cold storages and dearth of quality fodder seeds poses a serious problem. Mitigating scarcity of dry fodder and managing availability of green fodder round the year is a serious challenge for the livestock keepers as majority are marginal and small holders unable to produce and store livestock feed and forage and face acute shortage during certain periods especially during the rainy seasons. Problems encountered during transportation and storage that affect the quality of feed and forage and poses serious threat to animals. The quality is sub standard with poor protein and energy levels, failing to meet the nutrient requirement of the animal leading to poor performance. Dependence on by-products or grazing on common property resources viz., permanent pastures, wastelands, fallows lands, forests etc. are common. However, these resources are also dwindling over time (Feroze et al., 2010).

Table 1. Area under fodder crops and permanent pastures and other grazing lands during 2008-09 and 2014-15 (*thousand hectares*)

States	Fodder crops			Permanent pastures and other grazing land		
	2012-13	2013-14	2014-15	2012-13	2013-14	2014-15
Arunachal Pradesh	-	-	-	18	18	18
Assam	3	3	4	173	168	167
Manipur	-	-	-	1	1	1
Meghalaya	-	-	-	-	-	-
Mizoram	-	-	-	5	5	11
Nagaland	-	-	-	-	-	-
Sikkim	-	-	-	-	-	-
Tripura	-	-	-	2	2	1
Highest (Rajasthan)	4853	5370	4928	1694	1694	1674
All India	**7806**	**9249**	**9831**	**10314**	**10256**	**10258**

Source: *Directorate of Economics and Statistics; Ministry of Agriculture and Farmers Welfare, 2019*

Lack of Fodder marketing : A significant trading of crop by-products at village, state and inter-state is poorly managed and opportunity for improving it as a potential tool for contributing to the alleviation of fodder scarcity have not yet been explored. The fodder purchased in villages is mostly sold in urban and peri-urban areas. Most of the surplus paddy straw purchased from farmers field is sold after chaff cutting (processed). The wholesalers store the fodder while farmers receive only 35 % of consumers' price and 46 % of consumers' price is taken by middlemen as a profit margin, which is higher than food grain marketing (Singh et al., 2015). Also the small size and scattered nature of land holdings with low productivity per acre makes the collection of these surpluses for the purpose of marketing difficult.

Shortage of Storage facilities : There is lack of proper storage facilities for crop residues or by-products forcing the farmers to dispose off quickly by selling at cheaper rates to the middlemen or left to rot in the field. As most of the dairy animals in North Eastern parts of India are reared either by grazing or browsing system, during rainy season (June-September) green fodders are in plenty and mostly stall fed. But with the onset of lean season (winter), there is huge scarcity of fodders often met by the tree leaves available during the period (Chhetri 2010).

Prominent occurrences of Natural calamity : The North Eastern regions are highly vulnerable to natural calamity like heavy rains, flash floods, landslides, and earthquakes etc. This leads to major degradation of prime agricultural land, animals, lives and property. There is huge soil erosions leading to loss in fertility of soil.

Low adoption of growing Fodders : Lack of keenness in adopting high yielding varieties of fodder crops is prominent. Crops like Maize, Barseem, Soyabean, Napier etc. could be grown at such suitable temperature but there is reluctance in adopting this good practice.

Lack of intensive training : Due to the lack of proper education of the farmers and unemployed youth are more often not able to capitalize the various government schemes so all the benefits are not used up to the full potential.

Lack of water conservation measures : Though the North East is endowed with high seasonal rainfall and its dependence on monsoon rains but, rain water is neither harvested nor conserved for irrigation purposes.

Strategies for improving Feed and Fodder Scenario

- High yielding variety of fodder crops should be introduced through intensive research on existing feeds and fodders
- Identifying suitable variety all year round and participation of newer agri-technologies like integrated pest management system, appropriate soil and water management techniques etc.
- Low cost eco-friendly on-farm storage structures must be constructed in order to reduce post-harvest losses at production centres
- Feasible feed and fodder processing technologies must be introduced so as to preserve it during the lean season
- Grassland improvement scheme must be introduced and rain-water harvesting must be encouraged through appropriate watershed programmes and people's participation
- The hilly terrains and slopes of North East Regions may be used for plantation crops and livestock to supplement food production and extra income generation. The low use of pesticides in these regions fetches ample opportunity to convert any farming system in Organic products.
- Popularize institutional credit system for promoting high yielding variety of milch breeds, feed and fodder resources, entrepreneurship development, water harvesting, maintenance of soil quality and development of feed and fodder systems etc.
- Developing of good road network and rail transport system so as to deliver the produce in a smooth manner

- Skills development and technical exposure of farmers is necessary in order to tap the true potential of the region. Through extension services, institutions should demonstrate scientific know how of feed and fodder cultivation, processing and storage
- Hay making, ensiling and other methods of feed and fodder storage technologies must be encouraged so as to preserve excess forage biomass for the lean season.

Feed and Fodder shortage is a burning issue as the country is witnessing a growing livestock population. Proper management of crop residues and land use patterns through scientific technologies could optimize availability of feeds and fodder resources.

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SELECTION OF SIRES BY USING DIFFERENT SIRE EVALUATION METHODS IN CATTLE

[1*]Shashikant, [2]C V Singh and, [3]Mahendra Kumar Yadav
[1]PhD Scholar, AGB, College of Veterinary and Animal Science, Pantnagar
[2]HOD and professor (AGB) College of Veterinary and Animal Science, Pantnagar
[3]PhD Scholar, Aquaculture, College of fisheries, Pantnagar
***Corresponding author**: - Shashikantmy1@gmail.com

Introduction

Sire evaluation is the process of selection of breeding bulls to be the future sires for genetic improvement based on the performance of their progeny and relatives **(Henderson, 1973).** Evaluation of sires for their ability to transmit economic traits to their daughters has gained significant importance because, in males, high selection intensity could be practiced **(Smith and Banos, 1991).** Mostly, the sire evaluation is done in dairy cows and the genetic improvement depends on the accuracy of sire selection, selection intensity, generation interval and genetic variability of the traits considered **(Hagiya, 2019)**. Approximately, 61% of genetic gain in cattle derives from the selection of sires through two paths i.e., Bulls to breed cows and bulls to breed bulls **(Robertson and Rendel, 1954).** In dairy cattle sire evaluationbased on milk yield is most widely used criterion for estimating the genetic merit of a sire. However, other first lactation traits like peak yield, first lactation milk yield as well as reproduction traits like age at first calving, calving interval etc, also included in sire evaluation programme. In order to make rapid genetic progress in performance through selection for traits of economic importance, selected animals must be chosen for their superior breeding value **(Dalton, 1985; Falconer, 1989 and Nicholas, 1993)**. There are many sources of information, on which individuals breeding values can be estimated. These include individual performance, family performance and the combined performance of individual and family weighted appropriately after correlation for known environmental effects.

During the past, different methods like least squares method (LSM) and best linear unbiased prediction (BLUP) have been used to evaluate sires of indigenous breeds **(Parekh and Singh, 1989; Gandhi and Gurnani, 1991),** still the application of latest and complex method of sire evaluation like derivative free restricted maximum likelihood (DFREML) in Indian breeds is scanty. There are different methods of sire evaluation viz., Simple daughter average index (I), Contemporary comparison method (CC), Least squares method (LSM), Best linear unbiased prediction (BLUP), Restricted Maximum Likelihood Method (REML), Derivative Free Restricted Maximum Likelihood (DFREML) and GenomicBest Linear Unbiased Prediction (GBLUP) for single as well as multiple traits models. However, with the advancement of computational facilities, complex methodologies like DFREML as described by **Meyer (1989)** have been used during last few years for sire evaluation in different countries. The effectiveness of different sire evaluation methods was judged by using the various criteria like within sire variance or error variance, coefficient of determination (%), coefficient of variation (%) and rank correlations. The most efficient method had the lowest error variance. Higher the coefficients of determination (R^2-Value) from fitting a model, higher the accuracy. The sire evaluation method, which retains the coefficient of variation (CV %) of the population near to the (CV %) unadjusted data was the most stable method. Higher (near to unity)

rank correlation amongst the sires from different sire evaluation methods revealed higher degree of similarity of ranking from different methods.

History of Sire Evaluation

Denmark was the first country to start evaluating dairy sires in 1902 (Kumar, 1984). Sire evaluation was initiated with the single herd in the case of dairy bulls, with subsequent expansion to multi-herd evaluation **(Hancock *et al.* 2016)**. **J. L. Lush (1931)** elucidated principles of sire evaluation and also classical selection problem in random samples from the population in animal breeding had principally been explained by Wright and Lush **(Henderson, 1973)**. Varo worked on the evaluation of bulls from progeny testing in a different environment and concluded that relative evaluation methods based on deviation from herd average were more accurate to find the breeding value of sire for milk yield than theactual average yield of daughters **(Kumar, 1984).**

Cunningham (1965) proposed a method of least squares for analysis of sire effect from non-orthogonal data and evaluation of sires at an early age. The selection approach in case of sire evaluation was also mixed model selection, in which the candidates for selection are randomly drawn from more than one population and the merit of each is the sum of the subpopulation mean and the value of the particular random variable associated with that animal **(Henderson, 1973)**. **Smith (1936)** had initiated selection index methods successfully in plant breeding and **Hazel (1943)** proposed this theory of genetic correlations and revealed how to use these to estimate multi-trait selection indices in livestock. Genomic best linear unbiased prediction (GBLUP) is a method that utilizes genomic relationships to estimate the genetic merit of an individual. For this purpose, a genomic relationship matrix is used, estimated from DNA marker information. **(Clark and Werf, 2013).**

Brief introduction of different sire evaluation methods

Simple Daughters Average index ($\bar{D}$) Edward (1932)

The breeding values of sires were computed as follows: -

$$I = \bar{D}$$

Where, $\bar{D}$ is the average milk yield of all daughters of a sire under test

This is simplest measure in a **single herd** under **same environment** but it is subjected to biaswhen production level of mates allotted to different sires are different.

Contemporary comparison (cc) method

Changes in the environment conditions from time to time were of significance, then the relevant records made at different times needed adjustments. The value was based on the comparison of average of the daughters of the bull with average of the contemporary daughters of the same group but sired by different bulls. The difference between the two averages was weighted for the number of heifers in each sire group. The contemporary group will allow effective adjustment of major environment effects.

$$\mathbf{SI = \mu + \{n / n + k\} (D - C)}$$

where, SI = sire index

n = number of daughters; D = daughter's average; μ =population mean

C = average of daughters' contemporaries; k = ratio of error variance to sire variance

Least squares method (LSM) by Harvey (1960)

The least-squares normal equations result from the use of a differential calculus principle and to construct this set of equations, there must be one equation for each of the constants to be estimated. The least-squares principle minimizes the error variance after adjusting the data for various non-genetic factors. The **principle of LSM** is based on the square of the difference between the observed and estimatedvalue of the dependant variables must be least or zero. The estimation of the actual effect and prediction of the breeding values of sires were done sequentially in the population from statistical data **(Hill, 2014).**Most important drawback of LSM is its high sensitivity to outliers (i.e., extreme observations). This is a consequence of using squares because squaring exaggerates the magnitude of differences (e.g., the difference between 20 and 10 is equal to 10 but the difference between 20^2 and 10^2 is equal to 300) and therefore gives a much stronger importance to extreme observations. This problem addressed by using robust techniques that are less sensitive to the effect of outliers. This field is currently under development and is likely to become more important in the next future.

The **least squares** method (LSM) was used to estimate the breeding value of sires, using the following statistical model.

$$\mathbf{Yij = \mu + sj + eij}$$

Where, Y_{ij} =jth dependent single trait of the daughter of ith sire

μ =population mean S_i =effect of ith sire

e_{ij} =random error assumed to be normally and independently distributed with mean zero and variance σ^2 i.e., NID (0, σe^2)

Best Linear Unbiased Prediction (BLUP) by Henderson (1973)

Charles Roy Henderson (1973) developed the most efficient method of sire evaluation. BLUP can be exploited with various models to predict breeding values of bulls and to evaluate non-genetic effects. The basic steps involved in BLUP estimates are as an expression (model) that describes an individual's performances in terms of all factors, that need to be taken into account *i.e.,* herd-year-seasonmodel will be

$$\mathbf{Yijk = \mu + fi + sj + eijk}$$

Where,

Y_{ijk} = measurement on the k^{th} progeny of the j^{th} sire born in the i^{th} herd- year- seasonμ = over all mean

f_i = effect of the i^{th} herd- year- seasons_j = effect on the j^{th} sire born

e_{ijk} = residual error

The features of the BLUP method are as follows:

Best : Maximizations of the correlation between the true breeding values and predicted values or minimizes prediction error variance, **Linear**: Predicted breeding values are a linear function of the observations, **Unbiased**: Estimates of fixed effects are unbiased and are unknown, estimation of true breeding values for a random variable, such as sire's breeding values and **Prediction**: it comprises the prediction of accurate breeding values.

Restricted Maximum Likelihood Method by Patterson and Thompson (1971)

Patterson and Thompson (1971) proposed a restricted maximum likelihood (REML) approach which consider the loss in degrees of freedom resulting from estimating fixed effects. The REML method is capable to yield unbiased estimates for variance components of the linear model **(Patterson and Thompson, 1971).** The principle of maximum likelihood estimation (MLE), initially developed by R.A. Fisher which expresses that the appropriate probability distribution is the one that yields the experimentaldata ''most likely,'' which means that one must examine for the value of the parameter vector that utilizes the likelihood function. The MLE analyses the parameters by maximizing the logarithm of the likelihoodfunction. The fact of maximum likelihood is comparable to the least-squares principle for ordinary linear regression. The maximum likelihood estimators are biased, therefore the MLE is improved by a method known as restricted maximum likelihood (REML) which removes bias in estimates and avoids negative estimates of a component of variance (Searle *et al.* 1992). Also, the REML is used to maximize a modified likelihood that is free of mean components instead of the inherent likelihood in a maximum likelihood. REML estimation is available in a number of general-purpose statistical software packages, including Genstat (the REML directive), SAS (the MIXED proced ure), SPSS (the MIXED command), JMP (statistical software) and R (especially the lme4)

Derivative free restricted maximum likelihood (DFREML) by Meyer (1989)

Meyer composed a software package that used derivative free REML based on the likelihood ratio test to compare the significance of the variance components used in the model. DFREML supported 10 models that also included complex random regression. Now WOMBAT is the successor of DFREMLfor mixed model analysis using REML. Estimates of (co)variance components and heritability for breeding values and traits of the sire can be estimated by fitting a series of univariate animal models using a derivative-free REML algorithm. Permanent environmental and maternal genetic effects were considered by fitting random effects into the model of study. Indian workers observed that the DFREMLmethod was the most efficient and accurate for sire evaluation in Red Sindhi and Frieswal cattle using actual and predicted the first lactation 305-days milk yield. As per the results, it was suggested that the preference should be given to use the DFREML method followed by BLUP, SRLS and LSM methods forsire evaluation in Sahiwal **(Mallick *et al.* 2018 and Rajeev *et al.* 2021).**

Genomic Best Linear Unbiased Prediction (GBLUP)

Genomic Best Linear Unbiased Prediction (GBLUP) is uses genomic relationships calculated from genome-wide SNP's and is applicable in populations with incomplete or missing pedigree information. In GBLUP, all genetic markers have equal weight. GBLUP is specifically efficient for exact polygenic traits. The prior distribution of the GBLUP algorithm considers an equal variance overindividual locus. The availability of compact DNA marker information has facilitated the large-scale genotyping of individuals for the prediction of sire's genetic merit. To forecast the disease risk and genetic merit, the SNPs which are abundant on the genome have been utilized for wide scopes in human,livestock and plant genetics. These markers are useful for the detection of areas of the genome that have a significant effect on quantitative trait variation, the prediction of an individual's risk to disease infection and the estimation of heritability, genetic variance components to determine the genetic valueof individuals so that they can be selected for breeding purposes (Fernando *et al.* 2016).

RELATIVE EFFICACY OF DIFFERENT SIRE EVOLUTION METHOD

Banik and Gandhi (2006) estimated the breeding value of Sahiwal sires using least squares method (LSM), best linear unbiased prediction (BLUP) and derivative free restricted maximum likelihood (DFRELM). The lowest within sire variance or error variance and the highest coefficient of determinationof DFREML method as compare to other method. therefore, it was considered to be most efficient out of all the three sire evaluation methods. The alteration of CV with respect to unadjusted data (18.72% versus 19.89%) was lowest in BLUP, followed by least squares method. These findings depicted that BLUP method was the most stable method. However, the DFREML method seemed to be the most effective sireevaluation as compared value to other methods.

Table1.1 : Relative efficiency, Error variance, Coefficient of determination (R^2-value) and Coefficient ofvariation (CV) of different methods of sire evaluation.

Sire evaluation methods	Error variance (kg^2) (Efficiency)	Relative efficiency DFREML (%)	R^2 -value (%)	Coefficient of variation (CV)(%)
LSM	244,659.84	78.11	11.07	13.95
BLUP	251,747.19	75.91	24.54	18.72
DFREML	191,111.83	100.00	33.39	12.93

Kumar *et al.* (2008) analysed first lactation milk production records of (1122) Karan Fries cattle sired by 112 bulls to estimate breeding values of sires using derivative free restricted maximum likelihood (DFREML), best linear unbiased prediction (BLUP) and least squares methods (LSM) of sire evaluation. Result revealed that DFREML method more efficient, accurate and stable with lowest error variance, highest R^2 -value and lowest alteration of adjusted CV (%) to unadjusted records CV (%).

Table 2.1 : Error variance, Relative efficiency, Coefficient of determination (R^2- Value), and Coefficientof variation of different methods of sire evaluation

Method	Error varianc (kg2)	Relative Efficiency (%)	R^2 – value (%)	Coefficient of variation (CV) (%)
LSM	713302.20	78.20	26.86	28.65
BLUP	713956.74	78.13	18.70	28.66
DFREML	557870.15	100	29.17	30.10

Singh (2010) analysed the records (301) of Vrindavani crossbred (Zebu × Taurus) cows, progeny of 15 sires, to estimate the variance components, breeding values of sires and genetic parameters for first lactation 305 days or less milk yield using least squares method (LSM), best linear unbiased prediction (BLUP) and derivative free restricted maximum likelihood (DFREML). Lowest error variance and highestcoefficient of determination in DFREML method revealed that this method of sire evaluation was most efficient and accurate followed by LSM method of sire evaluation.

Table 3.1: Error variance, Coefficient of determination (R^2- Value), and Coefficient of variation of different methods of sire evaluation

Sire Evalua-tion method	Average breeding value (kg)	Number of sir equal or above average value	Maxi-mum BV (kg)	Minimum BV (Kg)	Difference	Total no sire	Error variance (kg2)	R2 (%)
CC	2134.43	31(53.0)	2369.43	1839.43	530	65	-	-

LSM	2137.20	37(43.9)	2705.2	944.2	1761	65	366049.81	25.8
BLUP	2137.17	33(50.0)	2656.17	1180.17	1476	65	372196.48	18.7

Pandey (2013) analyzed first lactation milk production records of 914 Vrindavani cows born out of 66 sires, over 23 years to examine the efficiency, accuracy and stability of 3 sire evaluation methods, viz contemporary comparison method (CC), least squares' method (LSM) and best linear unbiased prediction (BLUP). The average breeding value of CC, LSM and BLUP was almost similar. Result revealed that LSM had the lower error variance and heigh coefficient of determination(R^2-value) compared to BLUP. So, LSM was more efficient and more accurate method of sire evaluation compared to BLUP.

Table4.1 : Descriptive details of sires and relative efficiency of different sire evaluation methods

Method	Error variance (Kg^2)	R^2–Value (%)	Coefficient of Variation (%)
LSM	406657.42	17.72	22.71
BLUP	408399.80	13.30	22.76
DFREML	398919.70	26.70	22.80

Dongre and Gandhi (2014) estimated the breeding values of 51 Sahiwal sires from the actual and predicted FLMY by applying four sire evaluation methods viz., least squares, simple regressed least squares, best linear unbiased prediction and derivative free restricted maximum likelihood. The derivative free restricted maximum likelihood method had lowest error variance and highest coefficient of determination as compare to other method, for both actual and predicted first lactation milk yields and it was considered to be the most efficient method. The BLUP method was second efficient followed by LSM method.

Table 5.1 : Average expected breeding values (EBVs) of Sahiwal sires using actual andpredicted first lactation milk yield by different sire evaluation methods

	Actual First Lactation milk yield		
Methods	**Error Variance (kg^2)**	**Coefficient of determination (%)**	**Coefficient of variation (%)**
LSM	286272.56	20.10	27.81
BLUP	280416.84	18.20	27.53
DFREML	240431.64	21.50	27.34
	Predicted First Lactation milk yield		
Methods	**Error Variance (kg^2)**	**Coefficient of determination (%)**	**Coefficient of variation (%)**
LSM	249864.13	19.60	25.96
BLUP	242044.56	18.60	25.55
DFREML	199115.82	22.30	26.27

Geeta Lodhi *et al.* (2016) analysed the records of 1198 crossbred cattle sired by 102 bulls to estimate breeding values of sires using sire evaluation method, i.e., restricted maximum likelihood (REML), best linear unbiased prediction (BLUP), least squares methods (LSM) and simple daughter average (D). She revealed that the estimated breeding values of sires estimates for first lactation milk yield by BLUP showed small genetic variation in compare to (D), LSM and REML method. While

for life time milk yield and life time lactation length REML showed small genetic variation in compare to (D), LSM and BLUP methods, therefore BLUP and REML was considered as the most efficient methods out of all four methodsof sire evaluation used in this study.

Table 6.1: Average breeding value estimates for first lactation milk yield by different method of estimation

Traits	Sire evaluation method	Average breeding value	Minimum breeding value	Maximum breeding value	Number of sires over average	Number of sires below average breeding value	Range of Breeding Value
First Lactation Milk Yield	$\bar{D}$	2781.73	1718.25	6269.00	34	34	4550.75
	LSM	2779.19	1872.09	3907.69	27	41	2035.60
	REML	2710.46	2241.94	3166.45	32	36	924.51
	BLUP	2680.29	2309.49	3064.53	32	36	755.04
Life Time Milk yield	$\bar{D}$	11630.15	4747.20	78344.00	21	47	73596.0
	LSM	11127.19	1893.22	28213.54	26	42	26320.32
	REML	10371.02	9125.58	11536.10	20	48	2410.52
	BLUP	10705.59	9084.72	13268.20	27	41	4183.48
Life Time Lactation Length	$\bar{D}$	1392.00	584.33	1828.86	11	57	1244.53
	LSM	1110.54	531.93	2465.75	24	44	1933.82
	REML	1105.17	835.12	1365.55	31	37	530.43
	BLUP	1147.32	133.94	1316.34	38	30	1182.40

Singh and Singh (2016) reported the records of 1367 crossbred cattle sired by 112 bulls were analysed to estimate breeding values and to compare various methods of sire evaluation viz., BLUP and LSM. Sire evaluation methods on the basis of age at first calving, first service period, first lactation period, first dry period, and first calving interval. Result proposed that the LSM had minimum error variance and higher R^2 value for most of the first lactation traits and considered to be more superior over BLUP. The LSM method was most stable being its CV (%) which is closest to the CV (%) of unadjusted data.

Table7.1 : Effectiveness of different sire evaluation methods for actual and predicted first lactation traits

First Lactation Milk Yield (FLMY)			
Method	**Error variance**	**R^2**	**C.V%**
LSM	7.4E+08	40.5	44.16
BLUP	7.7E+08	38.3	42.93
First Lactation Length (FLL)			
LSM	7920813	18.17	25.8
BLUP	8143844	15.9	24.98
First Calving Interval (FCI)			
Method	**Error variance**	**R^2**	**C.V%**
LSM	2.3E+07	23.94	27.11

BLUP	2.4E+07	20.5	26.46
First Dry Period (FDP)			
LSM	1.7E+07	24.59	60.92
BLUP	1.7E+07	21.6	59.3
Age at First Calving (AFC)			
LSM	5.1E+07	48.47	16.45
BLUP	5.6E+07	43.3	16.47

Abbas *et al.* (2016) analysed records of 927 Sahiwal Cattle daughters of 72 sires to evaluate sire for firstlactation and life time traits. The breeding value of sire estimated by two methods viz. least squares and best linear unbiased prediction methods. It indicated that smaller values of coefficient of variation (C.V.%) and lowest error variances estimated by BLUP than least squares method (LSM). So, BLUP was the most efficient sire evaluation method. The estimated R^2- values in this study indicated that variabilityin the herd and genetic potentiality of the animals at this farm merely can improve through the introductionof the new germ plasm of Sahiwal cattle from outside of the herd.

Table 8.1 : Comparison of sire evaluation method-based Coefficient of multiple determinant (R^2), coefficient of variation (C.V. %), and error variance.

S. No	Traits	R2- value		C.V. %		Error Variance	
		BLUP	LSM	BLUP	LSM	BLUP	LSM
1	FSP	0.004	0.078	53.8	55.92	18041	19474
2	FDP	0.011	0.168	53.9	54.88	10212	10579
3	FCI	0.005	0.087	24.36	25.32	16601	17927
4	FLMY	0.003	0.127	34.77	35.63	246568	258996
5	LTMY	0.012	0.166	23.55	23.98	3502922	3634732
6	PL	0.152	0.404	9.61	9.64	99035	99575
7	HL	0.124	0.27	9.88	9.94	142667	144498

Choudhary *et al.* (2020) analysed the records of 91 cows, over 15 years (2002 to 2016). Sires were evaluated for first lactation milk yield by simple daughter's average method ($\bar{D}$), Contemporary comparison (CC) method, least-squares method (LSM), best linear unbiased prediction (BLUP) and by incorporating auxiliary trait. Results revealed that least-squares method is more accurate and efficient as it showed smaller error variance in comparison to all other methods for FLMY. When auxiliary traits were used with FLMY for sire evaluation the error variance was very high for all auxiliary traits. Among the sire indexes incorporating auxiliary traits, the lowest error variance was found when FDP was considered as auxiliary trait. This indicated that considering one trait along with first lactation milk yield may not be very effective criteria for ranking sires for FLMY in comparison to any other sire evaluation method.

Table 9.1: Average, range of sire's breeding values and error variance of various methods of sire evaluation for FLMY in Tharparkar cattle.

Method	Average breeding value	Range of breeding value	Error variances
$\bar{D}$	1849.1	695	61352.77
CC	1836.17	850.4	59532.53

Method	Average breeding value	Range of breeding value	Error variances
LSM	1858.65	342.6	8952.17
BLUP	1860.03	319.52	9729.79
AFC	1615.51	1980.92	442839.24
FSP	1527.47	1899.32	402754.82
FCI	1610.65	1906.12	414193.83
FDP	1527.50	1256.35	237498.90
FLL	1580.47	1954.8	421271.71

Conclusion

The advancement of mixed model methods, genetic evaluations providing more precise estimates of breeding value. Expending this methodology, it is possible to estimate the fixed effects by BLUE and random effects by BLUP. Therefore, the BLUP answer is acquired for all animals present in the pedigree. This approach precisely yields estimated breeding values which are mostly acknowledged as a selection tool in sire evaluation. DFREML assumes the maternal genetic or permanent environmental effects to assess the heritability and (co)variance components for breeding values and traits of the sire and it is most preferred method rather than BLUP, SRLS and LSM.

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CORAL REEFS : TROPICAL RAINFOREST OF THE SEA IS AT RISK

Virendra Kumar
Ph.D. Scholar
Kerala University of Fisheries and Ocean Studies, Kochi, Kerala, 682506
*Corresponding author - virendrak604@gmail.com

Abstract
Coral reefs are among the planet's most environmentally and commercially significant ecosystems. Coral reefs are covering 0.2% area of the ocean floor in the world. Coral reefs, sometimes known as the "tropical rainforests of the sea," support a population of 100 million people and are the foundation for sectors such as tourism and fishing, which generate a net yearly value of $30 billion US Dollar. They support about 25% of marine biodiversity and provide important ecosystem services, including coastal protection from waves, fisheries productivity, coastal erosion, medical supplies, recreational advantages, and tourism profits. Coral reefs found in more than 100 nations and territories in the world. However, they are greatly threatened by a variety of factors, including ocean acidification, global climate change, pollution from land runoff and unsustainable tourism and destructive fishing practices. Its research indicates that between 2009 and 2018, coral reefs of the world lost around 14% of its coral, due to recurrent massive coral bleaching outbreaks.

Keywords : Coral reef, marine biodiversity, livelihood, marine pollution, coral bleaching.

Introduction

Oceans occupy 70% of the surface area of the Earth, making it the largest ecosystem in the world, while coastal ecosystems including coral reefs, mangroves, and sea grasses include some of the world's most unique and valuable ecosystems. Coral reefs are complex and multicolored ecosystems hiding under the surface of ocean. Soft corals swing and bow among the rugged mountains of hard corals, offering extra habitat for fish, shellfish, snails, and other marine life. Coral reef ecosystem plays important role in the income generation of many people of tropical and subtropical countries. Coral reefs are also one the important attractions of tourist in the world, but these complex and colorful habitats have been threatened by human activity and natural causes. On a worldwide scale, the overall destruction of coral reefs is serious. Not only are coral mortality rates rising, but so is the concurrent severe decrease in coral growth rates.

Coral reefs

Coral is a member of the Anthozoa class of the Cnidaria animal kingdom, which also contains jellyfish and sea anemones. Corals create strong calcium carbonate exoskeletons that protect and support the coral, unlike sea anemones. A coral reef is an undersea habitat that is characterized by corals that build reefs. Coral polyp colonies are bound together with calcium carbonate to build reefs. Coral reefs are colonies of organism in which corals play a prominent structural role. Every polyp of reef secretes hard calcium carbonate skeleton.

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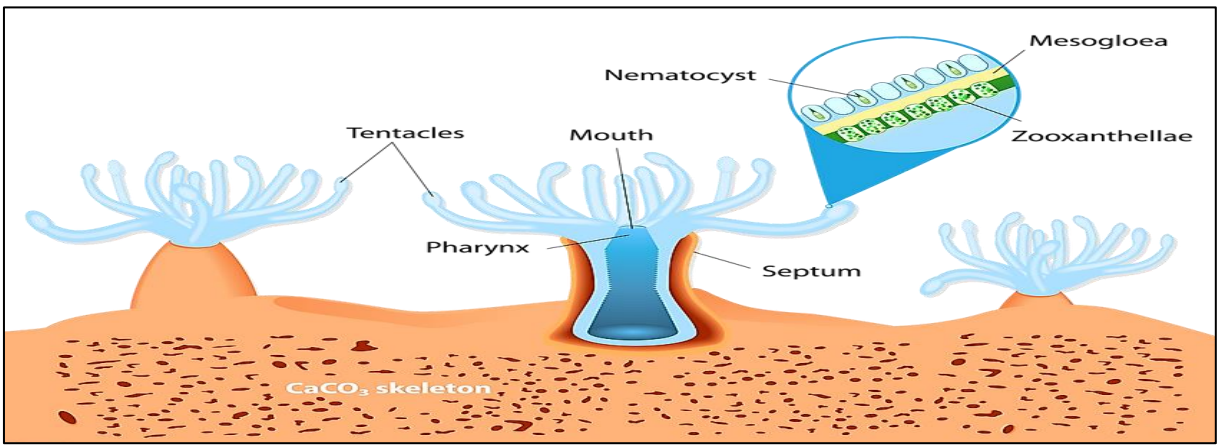

Figure-1. Coral anatomy

Zooxanthellae

Coral polyps do not photosynthesize, but they do have a symbiotic connection with zooxanthellae, which are tiny algae or dinoflagellates of the genus Symbiodinium. Corals rely on their symbiotic organism for up to 90% of their nutrition. In exchange, the corals protect the zooxanthellae, which number one million per cubic centimetre of coral, and provide a steady supply of the carbon dioxide they require for photosynthesis. The pigments in different zooxanthellae species give them a brown or golden-brown look, which is what gives brown corals their coloration. Other pigments, including as reds, blues, and greens, are produced by coral organisms' colourful proteins. Coral that loses a high percentage of its zooxanthellae turns white (or occasionally pastel colours in corals that are stained with their own proteins) and is said to be bleached, a condition that can kill the coral if not remedied.

Types of coral reef

1. **Fringing Reefs :** Built from the sea bottom and extend from the shore up to 1/4 miles having no navigable channel between the shore and reef. In the East Indies, this kind of reef is fairly prevalent.
2. **Barrier reefs :** The barrier reefs are like fringing reefs but they are situated in the sea nearly 1 km to 15 km away from the shore e.g. The Great Barrier Reef on the north-east coast of Australia.
3. **Atoll reef :** The atoll reef, coral island or lagoons island, is a circular or horse-shoe-shaped reef enclosing a lagoon of water which may be small or large up to 50 miles across. Aldabra in the Indian Ocean, about 260 miles northeast of the Malagasy Republic and 400 miles from the coast of Africa.

Why are coral reefs important?

- The worldwide worth of coral reefs is $9.9 trillion dollars.
- Approximately 500 million people were dependent
- They cover less than 1% of the earth's surface.
- It is home to 25% of all marine fish species.
- Pharmaceutical purpose such as treating cancer, HIV, and heart problem.
- Annually, 70 million tourism excursions are sponsored.
- Coastal protection by reducing energy of the waves by 97% before it reaches the beach.

- Control the quantity of CO_2 in the ocean using well-managed reefs that yield 5-10 tonnes of fish per km^2.
- Recycle nutrition as fix carbon and nitrogen by taking CO_2 from the atmosphere.
- Corals are filter feeders, consuming contaminants from water and so acting as water filtration.

Coral reef : At risk

- 75% of the world's coral reefs are currently threatened.
- 90% of coral reefs will be threatened by 2030.
- 100% of reefs will be threatened by 2050 if we don't take action now.

Status of World coral reef building coral in 2018 (according to FAO STATISTA, 2018)

1. Least Concern-42%
2. Vulnerable-28%
3. Near Threatened-25%
4. Endangered-4%
5. Critically endangered-1%

REASON TO GLOBAL THREATS CORAL REEFS

1. **Climate change :** Sea level rise, El-nino, Harmful algal bloom, Ozone layer depletion, Coral bleaching, Sea surface temperature rise, Ocean acidification, Global warming threats to more coral reefs.
2. **Natural threats :** Disease outbreak, Natural breakdown, Predation by crown, fish, Exposure, Hurricane, Tsunami etc. are reduced coral diversity day by day.
3. **Destructive fishing methods :** Blasting with dynamite, Deep water trawling, Use of Bottom Trawl in fishing, Ghost net, Dredging, Cyanide poison, Boat anchoring and Boats running aground are more destructive for the coral reefs.
4. **Human threats to the coral reefs :** Mangrove destruction, overfishing, Coastal development, Marine pollution and marine debris, Agricultural & industrial runoff, Global aquarium trade, Coral mining, Coral collection, Plastic and micro plastic colonies of reefs.

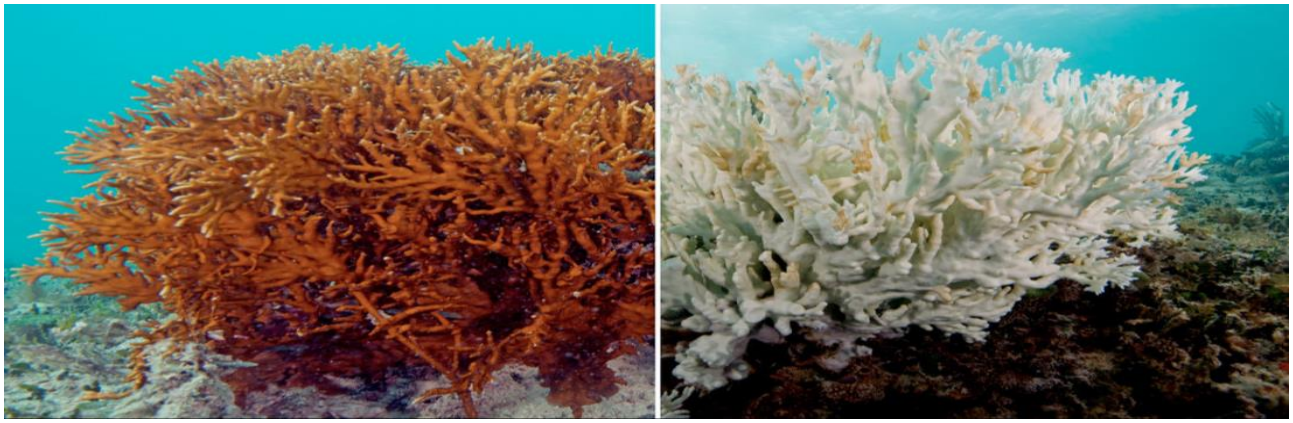

Figure-2. Healthy corals and bleached corals (white)

Steps for Conservation of Coral Reef

- Implement best practices for decreasing hazardous runoff in farming, grazing, mining, and forestry operations by establishing protected zones on land.

- Minimizing runoff and erosion by protecting and restoring damaged aquatic habitats and coastal habitats.
- To prevent erosion and nutrient runoff from agriculture, land-based sources of sediment and pollution are managed through coastal zone planning and enforcement, waste treatment, and integrated watershed planning.
- Improve present fisheries management strategies and construct fewer ports. Determine new fisheries management strategies, such as protected zones, gear limitations, and catch limits.
- Create strategies for long-term tourist management. Ship discharge, shipping channels, and anchoring in sensitive locations are all subject to restrictions.
- By increasing public knowledge about coral reef products and services
- Techniques for better reef resource management.
- Educate and disseminate information to communities, government agencies, funders, and the general public.
- Conduct and advertise economic valuations. Conduct scientific research, train, and create capacity
- Assist policymakers and planners with their work.
- Obey local rules and regulations aimed at safeguarding reefs and reef species.
- Select eco-friendly, responsibly managed tourist companies.
- Dive and snorkel with caution to prevent injuring reefs.
- Choose sustainably managed, eco-conscious tourism providers.
- If you notice someone doing something that would be hazardous to the corals, report authorities.
- Support planning and implementation by visiting and contributing to Marine protected areas.
- Gifts produced from corals and other marine animals should be avoided.

Steps for Restoration of Coral Reefs

- Without an intervening nursery period, coral colonies or pieces are transplanted.
- Nursery can be on-site (in the sea) or ex-situ (flow through aquaria).
- Providing artificial structures as a foundation for coral new recruits, coral planting, and/or fish aggregating for the goal of coral reef rehabilitation
- To aid coral recruitment or recovery, stabilize the substratum or remove unconsolidated material.
- After an interim collecting and processing phase, releasing coral larvae to a rehabilitation location. Immediately releasing larvae at a rejuvenation location.

Protection of coral reefs for sustainable livelihoods and development

- Don't go fishing or boating near a coral reef, and don't garbage on the beaches or in the water.
- Snorkeling and scuba diving should be done with caution, and coral souvenirs should be avoided.
- Volunteer to promote reef science and avoid destructive fishing tactics.
- Contribute to coral reef conservation groups and spread the word about coral reefs.

- Reduce the pollution in maritime habitats and conduct sustainable fishing.
- Multiple habitats are preserved via the creation, development, and administration of marine protected areas, biosphere reserves, parks, and sanctuaries.
- Coral habitat rehabilitation and rules must be properly enforced.
- Building (in-situ/transplanted) artificial reefs.

Conclusion

Coral reefs are vital to coastal communities and nations around the world. The threats to the world's coral reefs, however, are serious and growing. In the face of such pressures, it is critical that we focus on practical, immediate responses, such as those highlighted above, to reduce and to reverse these threats. Action now could ensure that coral reefs remain, and that they continue to provide food, livelihoods, and inspiration to hundreds of millions of people now, and for generations into the future.

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Official Address :
Peshok Tea Estate
P.O.- Peshok, Dist.- Darjeeling
West Bengal, India
PIN-734312

Contact No : +91 7501389678
email : agriindiatoday@gmail.com