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1. AGRICULTURE-HORTICULTURE

Speed Breeding Approaches in Vegetable Crops

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Abstract

By shortening the generation period and increasing the number of breeding cycles annually, speed breeding is a cutting-edge method intended to hasten agricultural progress. Speed breeding allows for the quick production of superior vegetable varieties by manipulating environmental factors such prolonged photoperiod, regulated temperature, optimal nutrition, and protected cultivation. Vegetable breeding programs have been transformed by the combination of speed breeding with contemporary technologies like genomics, marker-assisted selection, and genome editing. The concepts, methods, uses, benefits, drawbacks, and potential future developments of speed breeding techniques in vegetable crops are reviewed in this article.

Keywords: Speed breeding, rapid generation advancement, vegetable crops, controlled environment, crop improvement

Introduction

Due to lengthy generation cycles, seasonal restrictions, and complicated trait inheritance, vegetable breeding has historically taken many years to produce better cultivars. Accelerating breeding cycles has become a priority due to the growing need for healthy, climate-resilient, and high-yielding vegetables. By permitting several generations annually under regulated settings, speed breeding provides a workable approach that drastically reduces the breeding schedule (Watson *et al.,* 2018).

Concept and Principles of Speed Breeding

The idea of speed breeding is to maximize environmental factors to encourage early blooming, fast seed maturity, and rapid plant development. Optimal temperature regimes, regulated humidity, and extended photoperiods (20–22 hours of light each day) are frequently employed. These circumstances promote quicker physiological growth without negatively impacting the success of reproduction (Hickey *et al.,* 2019).

Key Techniques Used in Speed Breeding

1. **Extended Photoperiod and Light Management:** By extending the day, artificial illumination using LEDs or fluorescent lamps improves photosynthesis and speeds up blooming. Extended photoperiods greatly shorten the time it takes for plants like tomatoes, peppers, and cucumbers to blossom and set fruit (Watson *et al.,* 2018).
2. **Controlled Environment Cultivation:** Temperature, light, and humidity may be precisely controlled via growth chambers, glasshouses, and vertical farming systems. Even for vegetable crops that are sensitive to photoperiod, these conditions enable year-round breeding without regard to seasonal constraints, making speed breeding possible (Hickey *et al.,* 2019).
3. **Rapid Generation Advancement (RGA):** RGA involves harvesting seeds at physiological maturity rather than full maturity, followed by immediate sowing of the next generation. This approach allows multiple generations per year in vegetables like tomato, eggplant, and brassicas (Ghosh *et al.,* 2018).
4. **Integration with Modern Breeding Tools:** Marker-assisted selection, genomic selection, and doubled haploid methods are frequently used with speed breeding. Breeders can quickly eliminate subpar genotypes through early-generation selection utilizing molecular markers, increasing efficiency (Varshney *et al.,* 2021).

Applications of Speed Breeding in Vegetable Crops

Vegetables including tomatoes, chilies, cucumbers, lettuce, peas, and brassicas have all

benefited from speed breeding. It makes it easier for early-maturing cultivars, nutrient-enriched cultivars, and disease-resistant lines to grow quickly. Under regulated circumstances, tomatoes may produce up to 4-6 generations annually (Watson *et al.,* 2018).

Crop-Wise Examples

- Tomato: Rapid development of disease-resistant and high-yielding lines
- Chilli and Pepper: Accelerated breeding for capsaicin content and stress tolerance
- Cabbage and Cauliflower: Faster inbred line development
- Pea and Bean: Quick fixation of desirable traits through rapid cycling (Hickey *et al.,* 2019)

Advantages of Speed Breeding

- Shortened breeding cycle duration
- Increased genetic gain per unit time
- Year-round breeding independent of seasons
- Efficient integration with molecular breeding
- Faster response to emerging biotic and abiotic stresses

These advantages make speed breeding a powerful tool for modern vegetable improvement programs.

Limitations and Challenges

Despite its potential, fast breeding has drawbacks such expensive initial infrastructure, energy-intensive artificial illumination, and crop-specific adaptation. Under harsh growth circumstances, some vegetable crops may show decreased seed viability or changed morphology, requiring procedure adjustment (Watson *et al.,* 2018).

Future Prospects and Research Needs

Future studies should concentrate on creating speed breeding methods tailored to particular crops, enhancing energy-efficient lighting systems, and combining speed breeding with precision phenotyping and artificial intelligence. Vegetable crop development will be further revolutionized by combining speed breeding with genome editing and genomic selection (Varshney *et al.,* 2021).

Conclusion

Speed breeding represents a transformative approach in vegetable breeding by enabling rapid generation turnover and accelerated genetic improvement. Its combination with contemporary biotechnological and genomic techniques offers enormous promise to address upcoming food and nutritional security concerns. Speed breeding is anticipated to become a standard practice in vegetable breeding projects around the globe with further technology developments.

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2. ARTIFICIAL INTELLIGENCE-EFFECT

AI- A Boon or Bane to Job Security

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Introduction

The rapid advancement of artificial intelligence (AI) has become one of the most significant technological trends shaping our world today. As AI systems increasingly occupy various industries—from manufacturing and healthcare to education and finance—questions surrounding their impact on employment have taken centre stage. Will AI enhance job prospects by creating new roles and increasing productivity, or will it lead to widespread job displacement and insecurity? This pressing dilemma has sparked intense debate among professionals, policymakers, and workers alike, prompting a closer examination of how AI will influence the future of job security across different sectors.

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Mrinank Sharma—a senior developer in a renowned company who holds a degree in Computer Engineering from Cambridge and a PhD in Technology from Oxford— resigned from his job (shared his decision on social platform X on 09.02.2026) , stating that the world is in danger. Mrinank is now pursuing a degree in poetry. Why poetry? Is it not a strange turn of events, yet one that compels us to think deeply?

A major debate nowadays, is unfolding across the globe: Will artificial intelligence increase employment opportunities, or will it take away people's jobs? Experts believe that the nature of jobs will undergo a transformation; while there will undoubtedly be a shortage of jobs in the market, new employment opportunities will also emerge. Although the balance between these two aspects may vary, experts nonetheless maintain that Artificial Intelligence will lead to an increase in productivity. Since a decline in employment is inevitable, a consequent reduction in demand is a natural outcome that can be expected in the times to come.

We are all compelled to wonder which jobs or professions remain secure in this era of artificial intelligence. Is it the accountant's or software engineer's? Is it the content writer's? Is it the plumber's or electrician's? Is it the doctor's or the entrepreneur's? There are countless other such professions—listing them all would result in an incredibly long list.

The question to consider now is: what are the specific fields of work in which job security is likely to be maintained—or, in other words, where an individual's work and employment will remain secure?

Therefore, rather than dwelling on that, this is the time to reflect on which jobs—or whose jobs—are likely to remain secure, and why. To understand it one must realise that if one possesses the capability and competence, the development of any form of technology will serve not as an obstacle to your work, but rather as an aid—provided, of course, that you utilize it correctly. The invention of computer came with the prevailing sentiment that it would eliminate people's jobs. Yet, even today, we observe that it has served to create jobs rather than take them away. Therefore, one should remain confident that the development of artificial intelligence will prove beneficial for human civilization in the long run—provided, of course, that government enact appropriate rules and regulations.

Speaking of the present—and considering the discourse among the world's intellectuals, as well as the speeches and exchanges of words that took place at the recent AI conference in India—a sense of apprehension has undoubtedly emerged; However, alongside this, these very intellectuals have also put forward numerous suggestions, asserting that if Artificial Intelligence is utilized correctly and appropriately, it could prove to be a boon for the advancement of human civilization.

Returning to the subject of job security, it is pertinent to mention here that in all tasks requiring manual dexterity or skill, there

appears to be no risk of any form of job insecurity. As examples of such tasks, we can cite the work of teacher, plumbers, electricians, nurses, farmers working in the fields, hairdressers, doctors, cooks, and many others.

Take an example of a teacher. If a robot were assigned the role of a teacher, would it be able to discharge those duties successfully? No—absolutely not. Furthermore, what parent would ever wish for their children to be taught by a robot rather than by a human educator? If robots were to take up the task of teaching in schools, children would begin to shy away from studying. They would soon start to feel bored as well, and the consequences of this would be extremely terrible. Creativity, emotional depth, and curiosity in children will eventually vanish—a prospect that poses a matter of grave concern for human civilization and future generations. A child or a student always wishes to engage in discussion with the teacher, satisfy his or her curiosities, and find solutions to the problems. A human teacher would be capable of doing this, but for a robot, it would be impossible. A robot can never establish an emotional bond with children in the role of a teacher.At the same time a robot or AI can help a teacher to deliver lectures properly, to teach students with more creativity, to keep them updated. Therefore, an educator faces no threat of any kind from artificial intelligence. A robot can never be a replacement of a teacher but it can serve as an assistance.

Similarly, if we take the example of an entrepreneur, it is evident that artificial intelligence can never replace one. Starting a business invariably requires innovation, critical thinking, courage, curiosity, creativity, and keen observational skills. All these attributes can only be provided by a human being; neither machine nor any machine language can fulfill these requirements. Furthermore, market needs, consumer preferences, and market availability are requirements that can only be fulfilled by a human being. Therefore, it is evident that under no circumstances can artificial intelligence replace an entrepreneur. The author firmly believes that artificial intelligence cannot be a substitute for humans, although it can assist in performing various tasks.

Conclusion

It is not possible to discuss every type of employment here; therefore, it is appropriate to state that wherever human labour is required—or wherever specialized skills are needed—there is absolutely no risk of employment coming to an end. The AI does not pose any danger to such jobs. However, there are many white-collar jobs in which people's employment is at risk—or could be. Recent research indicates that computer programming, customer service, data entry operations, computer support services, and certain other fields are areas where artificial intelligence could reduce employment opportunities. But at the same time the new areas will too open in AI era. So please keep fingers crossed, update yourself with latest developments to keep your job secured.

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Note: The article is being published once agin in view of the fact that the same was published in others' name instead of Arpita Joshi. In contents other authors' names were published in previous issue. We are very sorry for that and are publishing this article with due correction in name.

3. ARTIFICIAL INTELLIGENCE IN AGRICULTURE

AI in Agriculture: Revolutionizing the Future of Farming

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At Global level the AI has become an important topic everywhere. The dependency

on AI is increasing with every passing day. There is no sector which could escape itself from AI and Agriculture is no exception. The AI is used in agriculture sector too and the same may revolutionize the future of farming.

As the world's population continues to grow, agriculturists, scientists, and farmers face a dual challenge: the pressing need to increase food production while ensuring that ecological balance is maintained. Meeting these demands requires not only boosting productivity but also addressing environmental concerns simultaneously. This delicate balance can only be achieved by leveraging the latest technologies, advanced equipment, and innovative ideas in agriculture.

This is where the importance of Artificial Intelligence (AI) becomes evident. AI holds the promise of tackling these challenges by introducing cutting-edge technologies designed to enhance agricultural productivity efficiently and sustainably. Through AI-driven solutions, it is possible to optimize resource use, monitor crop health, predict weather patterns, and manage pests and diseases with precision. Ultimately, AI aims to support the agricultural sector in meeting the growing food demand while preserving the environment for future generations. It undertakes to enhance productivity, optimize resources, and improve sustainability.

In this article, we shall discuss about how AI is used in different farming tasks, which will undoubtedly demonstrate the significance of AI in agriculture. This will also show how AI is changing farming practices around the world.

Precision Agriculture

Precision refers to accuracy and meticulousness and precision agriculture refers to the use of technology in order to monitor and manage the variability available in fields and ensuring that crops receive the correct or the optimal amount of resources needed. The human being use to do this with their skill and intelligence. To a great extent the exactness remains but it cannot error proof. AI plays a pivotal role in this. The data from various sources like satellites, drones, and sensors satellites, drones, and sensors are analysed first and then decisions are made. With the help of such data the farmers can take decision as to when the planting should be done, when and in what quantity the water and fertilizers to be supplied and when to harvest the crops. Since the data analysis provides information with accuracy so the productivity increases and the crop losses are reduced.

How AI helps in precision agriculture:

- The AI powered sensors are fixed in the soil or on machinery;
- The sensors collect the data on soil moisture, temperature, nutrient levels etc;
- Drones equipped with AI powered cameras and sensors capture the images of the field which helps the farmers to detect the sign of diseases, nutrient or pests deficiency;
- The data are analyzed with the help of various AI based tools;
- The information after proper data analysis is provided to the farmers;
- Such information help in deciding as to what quantity of water and fertilizer etc. are needed, what kind of treatment is to be given and to which part of the field the same is needed;
- The action taken on the basis of such available information not only improves the yields but also reduces the waste and increased the crop production.

Crop Monitoring and Disease Detection

In order to get good crop productivity the monitoring of crop is mandatory. In traditional system the human being used to do that. This traditional system is a time-consuming method and most of the time the chances remain that the humans can miss early signs of crop stress or disease. However, now the AI can help in this. AI can greatly improve the monitoring of crops. This monitoring can help the farmers in the early detection of diseases and the method is not time consuming too. AI simulations can analyze images and data to identify patterns. AI based imaging and disease predictions are possible with AI models and modules.

- **AI-based Imaging**: Drones and satellites which are used in agriculture remain equipeed with high resolution cameras and sensors. These

equipments can process high-resolution images and can identify signs of unusual patterns in the crops at an early stage. One should know that by using machine learning procedures or algorithms, these systems can predict the probable reasons which may be there for the crops like problems from pests, diseases, or environmental pressure etc.

- **Disease Prediction and Management**: AI tools are so advanced that with the use of past data and present monitoring the AI can even predict disease outbreaks, if any and can recommend preventive measures.

Autonomous Farming Equipment

AI is playing a pivotal role in the development of autonomous farming equipments like planters, tractors, sprayers, harvestors etc. Autonomous farming equipments mean machinery that operates without or with minimum human intervention. These equipments use advanced sensors, GPS and AI to perform the activity. As the Autonomous tractors, harvesters and sprayers etc. are equipped with AI systems which allow them to adjust speed and direction etc. so they perform the task efficientylay and effectively. The cost of labour is saved on the one hand and the time saving remains on the other hand.

Besides the automated systems allow the farmer to carry out following tasks automatically:

- Planting of seeds;
- Watering the crops;
- Harvest the crops;
- Spraying;
- Weed identification, controlling and removal;

The use of automated system not only brings the accuracy and efficiency but also reduces labour costs.

Supply Chain Management

The supply chain system has to be very strong so far as agricultural products are concerned. The agriculture produces:

- Remains perishable in nature and requires delivery to the destination well within the time;
- They need to be saved from climatic conditions and bad weather;
- Minimum transit loss has to be ascertained.

The AI can take care of such hurdles and it has the abilities of providing the best ways to supply the agricultural produce from farm to the consumers. It enables the users to analyse various data and decide the pattern of supply chain management. With the help of AI the climatic conditions, demand of produce, market trends etc. can be predicted. After taking into considerations one can take decision and save on cost and reduce the wastage of produce/crops. Similarly, the shortest routes can be planned with the help of AI which would certainly enable the farmers to arrange quick delivery at the destination. The also allows the farmers to save cost of fuel. Timely delivery at destination would also save those products which are perishable in nature thereby avoiding the wastage of the products.

Sustainability and Environmental Impact

The environment protection and ecology balances need to be maintained since agriculture is the most resource-intensive industry. It requires massive quantity of water; it requires enormous size of lands, needs huge quantity of chemicals and pests etc. All these have effect on environment and sustainability. AI can help to reduce environmental impact as its algorithms may provide more sustainable practices for the agriculture sector.

The availability of water is very critical since huge quantity of water is needed for agriculture. The AI based modules can help in optimizing the usage of water and to manage available water as well as the use of chemicals in the following manner:

- The tools may predict the weather, the rainfall pattern, the monsoon position;
- Probable rainfall with great accuracy may also be predicted;
- It can also analyse the soil moisture levels and water requirement in the fields;

- The irrigation schedule too can be provided by the AI;
- The specific area can be identified, with the help of AI, which need use of pesticides and fertilizer. This specific determination helps in:
    - Reducing the excess use of chemical and fertilizer;
    - Reducing the cost of chemicals;
    - Preventing the soil degradation because of excess use of pesticides etc.;
    - Reducing the adverse environmental impact;
    - Increasing better farming practices; and
    - Increasing in crop production.

Challenges and the Future of AI in Agriculture

We have seen the importance and use of AI in agriculture. We find that there are huge opportunities for agriculture sector so far as use of AI is concerned. Although the extraordinary and exciting potential is there yet it is not that easy. There are numerous challenges in extensive use of AI in this sector. The following are the limitations of AI in agriculture:

1. Huge cost for the technology;
2. Need of vast data structure;
3. Data privacy and data security concerns;
4. Non availability of technical experts;
5. Fear of potential displacement of labour;
6. Technological limitations;
7. Lack of complete infrastructure- like low connectivity, low electrification, non availability of electricity round the clock etc.;
8. Unwillingness to adopt new technologies.

Despite the above challenges and various limitations the AI technology is becoming popular in agriculture field. It is continuously progressing towards becoming affordable. The AI has become more popular. It is attracting people and has become more accessible to the farmers and agriculturists. Moreover, the investments, by the Government and public and private organizations, different kinds of solutions for the farmers are available which help them fight with food security and ecology imbalances. With the help of AI global information has become local and is accessible and available to all. The farmers who used to follow indigenous system are now equipped with excellent tools and information to compete at global level.

Conclusion

Artificial Intelligence is revolutionizing the whole agricultural sector. It aids in cost reduction, enhances productivity, facilitates the measured application of chemicals and fertilizers, optimizes water usage, and empowers farmers to adopt sustainable agricultural methods. This technology is evolving swiftly and enhancing significantly over time. The enhanced knowledge, equipment, skills, and expertise will undoubtedly play a crucial role in the future, and it can be asserted that this technology will significantly influence the future of agriculture, enabling farmers to satisfy the demands of a large global population without detrimental effects on environmental conditions.

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4. PLANT PATHOLOGY

Secretion Systems in Phytopathogenic Bacteria

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Secretion systems are essential for phytopathogenic bacteria to produce surface structures for adhesion, aggregation and bacterial motility, as well as to secrete cell wall–degrading enzymes, proteases, toxins, and effectors to defeat and reprogram host cells. Moreover, secretion systems arm bacteria to compete against other microbes and also equip bacteria with a mechanism to share nucleic acids and influence virulence evolution. The secretion systems are each designated as a type “X” secretion system (TXSS), with X being

an Arabic number replacing the Roman numerals I–VII traditionally used to designate the different secretion systems.

Types of secretion systems:

Type I Secretion System

Type I secretion systems (T1SSs) require three specific components and hydrolyze ATP during translocation. The T1SS consists of an ATP-binding cassette (ABC) transporter, a membrane fusion protein and an outer membrane protein. Members of the ABC superfamily are found in all domains of life and function to transport a diversity of molecules. The ABC transporter consists of two transmembrane domains, which contribute to cargo specificity and translocation, as well as two cytoplasmic nucleotide binding domains. Subsequent binding and hydrolysis of ATP by the ABC transporter induce conformational changes that result in the transmembrane domains adopting conformations sufficient to secrete unfolded polypeptides.

Type II Secretion System:

The T2SS can also secrete proteins exported by the Tat system. As a prerequisite, its cargo must be folded proteins. A fully assembled T2SS has not been determined but structures for each of its four substructures have been visualized and are suggested to be found in various compartments of the bacterial cell. An ATPase located in the cytoplasm provides the energy for translocation. It is associated with the cytoplasmic membrane via a platform located in the inner membrane that functions to connect the four substructures. T2SSs also have a fibrous periplasmic pilus-like structure, referred to as a pseudopilin because of its location within the envelope rather than the cell surface.

Type III Secretion System :

The virulence-associated type III and flagellar secretion systems are similar in structure/function and are both referred to as T3SSs. To distinguish between the two, nonflagellar (NF), virulence (v), or translocation-associated can be appended to T3SS of the former type, and flagellar (F) can be appended to the latter type. Given the topic of this review, T3SS is used in reference to nonflagellar type III secretion systems. The T3SS is the most intensively studied system in the context of pathogenesis, and its prominence is exemplified by the number of excellent reviews. Indeed, most gram-negative plant pathogens, with a few notable exceptions, require a T3SS to infect their hosts. However, despite being virulence associated, the T3SS is also used by mutualists and commensalists of plants. The key function of the T3SS is to inject type III effectors (T3Es) directly into host cells

Type IV Secretion System:

The T4SSs can be separated into three subtypes on the basis of their primary functions in DNA conjugation, DNA uptake/release, and cargo translocation. It should be noted that during conjugation, a protein pilots the DNA to the secretion system, suggesting that this subtype of T4SS should still be considered a protein secretion system. The T4SS is the most versatile of the secretion systems. The T4SS and homologs of its components are found in gram-negative, gram-positive, and wall-less bacteria as well as Archaea.

Type V Secretion System:

The T5SSs are relatively simple in composition and generally specific to a single cargo. T5SSs are subtyped as T5aSS–T5eSS on the basis of differences in structure and mechanism of secretion. The T5aSS and T5bSS correspond to the monomeric autotransporters and two-partner secretion systems, respectively, which are detailed below. T5dSSs are fused two-partner secretion systems that encode domains homologous to those belonging to the T5bSS subtype but are expressed as a single polypeptide. Finally, T5eSSs have the order of the two domains inverted relative to that of T5aSSs and the mechanism for secretion is also different.

Type VI Secretion System:

The type VI secretion system (T6SS) is a promiscuous secretion system that can translocate cargo into bacterial and/or eukaryotic cells. This is the most recently discovered secretion system, and its mechanism of secretion is an active area of research. The core of the T6SS consists of 13 proteins that are hypothesized to be minimally necessary for function. Three proteins, two of

which have homology to components of the T4bSS, are inferred to form a cell envelope–spanning membrane complex. Other proteins exhibit homologies to components of contractile tail bacteriophages. Hemolysin coregulated protein (Hcp) forms a hexameric ring that assembles in vitro into a hollow tail-like structure with the potential to accommodate unfolded or even small folded cargos. The valine/glycine-repeat protein G (VgrG) is similar to rigid and sharp spike-forming proteins of bacteriophages that are hypothesized to pierce through membranes.

Type VII secretion system of gram-positive bacteria:

The numerical nomenclature we adopted in this review was originally developed for secretion systems that translocate across both the cytoplasmic and outer membranes. It has therefore been argued that the type VII secretion system (T7SS) should not be used for ESX [ESAT-6 (early secreted antigenic target 6) secretion system] to be discussed in this section because T7SSs have only been characterized in gram-positive bacteria. We, however, continue to use T7SS because this secretion system is found in members of *Mycobacteriaceae*, *Corynebacteriaceae* and *Nocardiaceae*, all of which have a mycolic acid–containing outer membrane. Furthermore, the abbreviations T2SS and T4SS are also used to describe homologous components present in gram-positive bacteria. T7SSs are best known as specialized secretion systems for translocating cargo across membranes of mycolic acid–containing bacteria. (Lara *et al.,* 2007)There are five known T7SS subtypes (ESX-1–5) that vary in the organization of their corresponding loci. Each of the five share a limited number of core components. Few have determined structures, but models predicting their organization have been constructed on the basis of experimental data and computational predictions

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5. HORTICULTURE

Value added Products of Arecanut

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Among plantation crops arecanut (*Areca catechu L.*) is an important crop. It is seed of arica palm which grows in much of the tropical Pacific south east Asia and east African countries which is commonly known as betel nut, supari and Shrivardhani.In India it is extensively used by large sections of people and very much linked with religious practices. India is the major producer and consumer of arecanut in the world and ranks first in terms of both area (58%) and production (53%), major states cultivating this crop are Karnataka (40%), Kerala (25%), Assam (20%), Tamil Nadu, Meghalaya and West Bengal.The areca nut is not a true nut, but rather the seed of a fruit categorized as a berry. It is commercially available in dried, cured, and fresh forms. When the husk of the fresh fruit is green, the nut inside is soft enough to be cut with a typical knife.The pericarp (60%) is hard and fibrous and the kernel (seed 40%) is called areca nut which is about 2.25-3.25 cm in diameter, 2-3 cm long, varying in shape from conical to spherical and brown in colour with the white tints. In ripe fruit, the husk becomes yellow or orange and as it dries the fruit inside hardens to a wood-like consistency can only be sliced using a special scissors. The fruit has a fibrous mesocarp, seeds with a truncate base and endosperm deeply ruminates with a basalar embryo usually for chewing. The nut is offered to guests with few slices of the nut wrapped in along betel leaf,along with slaked lime and other flavouring spices like cardamom, clove as a mark of respect. India also exports limited quantity mainly in the form of 'Pan Masala' and 'Gutka'

Chemical composition: Arecanut have pharmacological properties attributed to its biochemical components such as polyphenols,

alkaloids, fat and proteins. Areca nuts are chewed with betel leaf for their effects as a mild stimulant, causing a warming sensation in the body and slightly heightened alertness. The arecanut contains the tannins arecatanin, gallic acid along with main 3 alkaloids arecoline, arecadine and guavacine which have vasoconstriction properties. Tender nut contains tannins 30-37 %, while ripe nuts have only 16-22 % tannins obtained as by-product from tender nut processing can be utilized for drying clothes, dye and adhesive. The nut also contains 8-12 % fat, rich in myristic acid. The husk of arecanut constitutes 60-80% of the total weight of fresh nut.

Processing: The fruit is harvested at different stages of maturity& consumed in different manners. Ripe fruits are generally harvested for a large scale sale, fastest way to get ripe fresh fruit, shell it with a knife and then cut it into four pieces or cured in flowing water for some period forloosening the husk which can be removed by hand. In some cases, nuts are cured in the pits with cow dung and leaves for several months. Decanted nuts are processed further based on their purpose and value.

Value added products

1. **Fully ripe Arecanut** after preserving are used throughout the year, by steeping using sodium benzoate and potassium metabisulphatesolutionalong with blanching is suggested to eliminate the foul smell and improve the quality of nuts.
2. **Dried ripe nuts:** Amongdried whole nuts,the most popular trade form of arecanut is known as Chali or Kottapak, wherelongitudinally cut ripe nutsare sun dried for 35-40 days, aroundmoisture content 12%, dehusked and marketed as whole nuts, after final drying.The kernels are scooped out and graded on sizeas Moti, Srivardhan, Jamnagar and Jini are in decrease order.The main producing areas of chali are Kerala, Karnataka, Assam and Maharashtra.
3. **Kalipak** is red form of tender processed arecanut produced in Kerala and Karnataka, dark green color soft nuts of 6-7 months are selected, boiled, dehusked and dried. Dried nuts are coated with Kali whichgives a good glossy appearance. A well-dried kalipak has dark brown colour, crispy and astringent flavour.
4. **Scented Supari**: Rose essence along with menthol is said to be used to manufacture this supari, yet flavouring of supari varies with region and is a closely guarded secret. Dried arecanuts are broken into bits, blended with flavour mixture and packed. In South India, scented supari is made from kalipak like batlu packed in butter paper, whereas in north and central Indiascented supari is available intwo type's chali and kalipak. Kalipaks and scented supari are mainly used as a masticatory, whereas chali and ripe arecanuts leave a large fibrous residue in the mouth are used along with betel leaf and slaked lime. Paan-beedasor Beeda is a popular ready-made supari consumed after meals and a religious trend gifted to guests made from combination of betel leaves, supari along with spices such as cloves, coconut gratings, sugar crystals or saccharin and also katha, the extract of Acacia catechu.

Conclusion

Plantation crops are most cash crops that need kind attention for its proper processing and maintenance. Coconut, arecanut etc., offer many possibilities which can be utilized for augmenting the farm level income by the farmers, diverse products could be produced by adopting technologies for a better tomorrow. Interventions and popularizations of arecanut based products are imperative for exploitation of arecanut based products to enhance the level of value addition. Commercial advanced technologies for drying should be established to prevent harvest losses and value addition.

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6. ANIMAL PRODUCTION

Heat Stress Management in Dairy Cows

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Introduction

Heat stress has several serious and economically deleterious effects on dairy cows. The most important effect of heat stress in dairy cows is reduced feed intake, milk production, butterfat percent and lower reproductive performance. Heat stress occurs in animals when there is imbalance between heat production (thermogenesis) within the body (gain) and heat dissipation (thermolysis) from the body i.e. impaired thermoregulation. Increased ambient temperature may lead to enhanced heat gain as compared to heat loss from the body and cause heat stress in animals. Heat stress is an inevitable part of life during the summer for dairy farmers in India. When feed is converted by the animal's metabolism for the production of milk, eggs, meat, offspring etc., heat is produced as a by-product.

Signs of Heat Stress in Dairy Cows:

- Restlessness
- Animals become lethargic and inactive
- Reduced appetite (decreased dry matter intake) to minimize metabolic heat production
- Increased thirst and more crowding around the water tanks
- Crowding under shade
- Prefers standing than lying down
- Reduced activity but increased respiration rate
- Increased sweating and panting to lose more heat (help thermolysis)
- Increased salivation
- Rise of rectal temperature
- Maintenance requirement may increase by 20-30% in animals under heat stress.

Effect of Heat Stress:

Effect on Feed Intake:

During high environmental body temperature, the animals try to maintain body temperature by minimizing metabolic heat (heat produced during feed digestion and nutrient metabolism) by reducing their feed intake. But this will lead to low energy intake by animals. At temperature of 25-26^{o} C feed intake in dairy animal begins to decline and drops more rapidly above 30^{o}C. Heat stress in high producing lactating dairy cows results in considerable reduction in appetite, roughage intake and rumination.

Effect on Milk Production:

During hot and humid weather conditions, there is reduction in intake of the nutrients in dairy cow which are otherwise necessary for production of milk as well as for body maintenance. It has been estimated that reduction in milk during heat stress is mainly, due to less feed intake on one hand and increased maintenance requirement, which reduce feed efficiency on the other hand. Milk yield usually reduce 10-15% or more during this period.

Effect on Reproductive Efficiency:

Adverse effects of heat stress on reproduction include reduction in estrous activity, estrous duration, heat detection, follicular development, oocyte quality, semen quality, conception rate, pregnancy rate, uterine function, multiple ovulations and twinning, suppressed intensity of estrous, a reduction in the strength of the preovulatory LH surge, a decreased secretion of progesterone, altered follicular development, decreased embryo development as well as fetal growth and reduced fertility. It is clear that heat stress has many effects on the reproductive axis, some are direct effects on the hypothalamus, the anterior pituitary gland.

Effect on Health of Dairy Cows:

During hot and humid weather conditions, the animals become more vulnerable to diseases. There is an increase in the somatic cell counts (SCC) and a higher incidence of mastitis and increase in number of flies during summer aggravates the situation.

Higher risk of acidosis: This is mainly due to decreased dry matter intake with lower proportion of forage and higher levels of fermentable carbohydrate, decrease in rumination, saliva in gut and buffering power due to increased CO_2 expelled. Additionally, the decreased rumen pH impairs fibers digestion efficiency as rumen fibrolytic bacteria is affected due to drop in rumen pH (below 6.0). Acidosis is found to affect the animals overall health status, fertility and longevity.

Strategies to Mitigate Heat Stress in Dairy Cows

1. Nutritional Strategies:

- Feed Total Mixed Ration or forage more frequently during cooler periods of the day
- Provide a cool area for forage feeding
- Possibly sprinklers over feeding areas
- Increase the energy and protein density of the diet
- During summer period, it is recommended that 75% of green fodder feeding
- Reduce the amount of fiber in the diet to minimize the metabolic heat production
- Soaking of concentrate in equal amount of water for 20-30 minutes helps in better utilization of nutrients and reduces dustiness in concentrates.
- Increasing the amount of dietary fat has been a widely accepted strategy in order to reduce basal metabolic heat production. Supplementation of palm oil significantly reduced rectal temperature and respiratory frequency, increased milk yield, reduced dry matter intake and increased feed efficiency in lactating cows.
- Natural and synthetic antioxidants in the feed as well as optimal levels of minerals, principally selenium, help to maintain efficient levels of endogenous antioxidants in tissues.

2. Management Strategies

- Shades is the cheapest way to avoid heat stress
- Milking time- On hot day we must milk and feed animals early in the morning
- In hot summer months sprinkling of dairy animals before morning and evening milking period
- Keep cows as cool as possible by using fans, shades, foggers, misters, air conditioners, water bathing and adequate air circulation
- Provide plenty of cool, clean water

Conclusion

Heat stress in dairy cows can challenge the reproductive and productive potential of animals. Implementing proper managemental strategies at farm with better feeding programme can help to minimize some of the negative effect of heat stress.

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7. HORTICULTURE-FLORICULTURE

Cultivation Techniques of China Aster

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Introduction

Scientific name: *Callistephus chinensis* L. Ness

Family: Asteraceae

It is native to Northern China and has spread to Europe and other tropical countries during 1731 A.D. The present day asters have been developed from a single form of wild species, *Callistephus chinensis*. The name of the genus '*Callistephus*' is derived from two Greek words 'kalistos' meaning 'Most beautiful' and 'stephos', a crown, referring to the flower head. It is one of the most important annual flower crops grown in most parts of the world. Among annuals, it is ranked third for popularity, after chrysanthemum and marigold.

Characteristics

It is also called Annual Aster. It is a half hardy annual, plants are erect with branching habit. Plants are erect bearing alternate, broadly ovate or triangular-ovate, irregularly toothed leaves. Flowers are solitary. Blooms contain two kinds of florets: ray florets and disc florets. The discs are short and ray florets are long. Semi-double or double. It has a wide array of varieties and the height ranges from 6 inches to 3 feet. They have daisy-like or star-like flower heads (4-6" in diameter) with a yellow center often tall stems. Their colors vary from white to creamy yellow, pink, blue, red and purple.

Soil

Open sunny locations with well drained red loamy soils with pH of 6.0 to 7.0. Water logged soils are not recommended

Propagation

China aster is propagated through seeds. A seed rate of 250 – 300 g/acre is sufficient. The seeds will not have dormancy and germinate in a week at about 21^{o}C. The seeds loose viability at a faster rate if stored in ordinary containers for a longer time, therefore it is advisable to use only fresh seeds. Normally the seeds germinate at a temperature range of 10-35 ^{o}C. The optimum temperature being 21^{o}C + 4 ^{o}C.

Cultivars and Varieties

Some of the public sector varieties released by IIHR, Bengaluru - Arka Aadya, Arka Shashank, Arka Archana, Arka Poornima, Arka Kamini and Violet cushion and varieties released by MPKV, Rahuri - Phule Ganesh White, Phule Ganesh Pink, Phule Ganesh Violet and Phule Ganesh Purple.

Nursery Operations

The seedlings are raised on nursery beds of size of 1.0 m width and convenient length. The beds were first drenched with captan (0.2%) and seeds were sown thinly and uniformly in lines and covered with a mixture of well rotten FYM and top soil. Seeds are to be treated with Captan (2 g / kg seeds) for five minutes and then sown in lines. The nursery beds are to be watered twice in a day for the first 10 days and thereafter once daily for the remaining period. The seedlings were ready for transplanting at 45 days after sowing.

Land preparation and Transplanting

The field should be ploughed thoroughly and brought to a fine tilth. About 10-15 tonnes of well-decomposed farmyard manure may be incorporated in the soil at the time of soil preparation. In areas receiving high rainfall the seedlings should be planted on ridges to avoid chances of Fusarium wilt. A general spacing of 30 x 30 cm may be optimum for recommendation.

Fertilizer Application

Application of manure and fertilizers in required quantities is important for proper growth, yield and quality of flowers. The deficiency of nitrogen causes dwarfing of the plants resulting in small sized plants and flowers. Phosphorus deficiency causes delayed flowering. The recommended fertilizer dose is 72:48:24 kg NPK/ha. Of which 36 kg nitrogen, full dose of P & K has to be applied at the time of preparation of land. Remaining 36 kg/acre nitrogen has to be applied as top dressing at 40 days after transplanting.

Irrigation

Irrigation requirement depends upon the weather, type of soil and season of the crop grown. Since China aster is a shallow rooted crop, it needs continuous soil moisture throughout the entire period of crop growth. It requires irrigation at intervals of 7 to 10 days.

Pinching

Pinching of main shoot at one month after transplanting promotes growth and development. Pinching delays flowering by 8-12 days.

Harvesting and Post Harvest Handling

Flowers are ready for the harvest in 70-80 days after transplanting. Flowers can be harvested in two ways. Loose flowers are used for decoration and religious offerings. Flowers with longer stalks and larger booms are harvested with stalks for use as cut flowers for fetching higher prices in the market. Cut flowers are to be placed in cool and clean water for maintaining turgidity with cut ends in water. Grading has to be done based on the length of the stalk. Loose flowers are to be packed in gunny or plastic bags and transported to the market.

Yield

On an average fresh yield of about 8-9 tonnes per acre during rainy season, 6-7 t per acre in winter and 4-5 t per acre in summer can be obtained.

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8. NANO TECHNOLOGY

Application of Nanobiotechnology in Agriculture

Patel Nidhi, Parekh Vipulkumar, Desai Bimal S. and Patel- Mohiniben

Gujarat

Agriculture

Agriculture is primary and stable sector due to it furnishes raw materials, mainly for food and feed industries. The limitation of natural resources (production land & water), the escalated growth of the population in the world, the increasing global food security and the global warming, claim the agricultural development to be economically further, viable, environmentally and expertly. The provocation of providing sufficient food supply becomes more remarkable when we notice depletion in crop yield annually. Plant pests, pathogens and various environmental factors subscribe towards low crop productivity. Nanobiotechnology is a promising appliance for sustainable agriculture.

Nanobiotechnology

Nanobiotechnology is term derived from two distinct worlds of molecular biology and engineering. Molecular biologists have been working for many years in the area of molecular and cellular features ranging from nanometers to micrometers structures to enable rapid and elevated density electronic chips, mean while Engineers have been working for many decades on diminishing the proportions of fabricated which have reached feature sizes as nanoscopic as 20 nm. It is assumed that a fusion of these two disciplines will be outcome in a brand new class of versatile devices and systems for biological and chemical analysis designated by better sensitivity and precision and higher rates of recognition compared with current interpretations. Collaboration is often the spark plug that ignites the next big idea.

Application

For Precision Farming

Conventional farming cannot supply increased food demand nor it is safe for environmental conditions due to it uses lots of pesticides and fertilizers. This technology holds the agreement of supervised site specific delivery of agrochemicals and macromolecules like herbicides, pesticides and fungicides needed for improved plant disease resistance, efficient nutrient utilization and enhanced plant growth. Nanotechnology based by-products and its implementation in agriculture include nano-fertilizers, nano-herbicides, nano-pesticides, nano-scale carriers, nano sensors, recognition of nutrient deficiencies, etc.

Nano-Fertilizer

With increasing food demands in the world, farmers use conventional fertilizers in higher amount which are chemicals, which are with high costs and more retent in the soil and water and it is the anthropological factor that

has caused the eutrophication of coastal and freshwater ecosystems. To overcome this problem scientist developed nanofertilizer with hydroxyl apatite, TiO2, SiO2, or even carbon nanotubes. Plants uptake it by two ways: 1) nanoparticles enter through pores of plant cell walls, 2) dissolution of the nanoparticles in soil or water and absorbed by plant root system. Researchers have explored that interchange between gold nanoparticles (GNPs) and plant growth promoting rhizobacteria (PGPR) gives a remarkable rise in growth for some of the strains, like *Pseudomonas fluorescens, Paenibacillus elgii and Bacillus subtilis*. GNPs have significant probability as nano-biofertilizers.

Nano-Pesticide

Pest management is largely based on conventional pesticides today. Pesticide use has been concerned with mammalian toxicity, environmental contamination and bioaccumulation. "Nano pesticides" is a designing of novel active ingredients with nanoscale as well as their formulation and delivery. In order to preserve the vital ingredients from the environmental conditions and to encourage persistence, nanotechnology approach 'nano-encapsulation' as it may be utilized to enhance insecticidal value. Enhance the effects of pesticides are found in iron oxide nanoparticles and gold nanoparticles because they are commonly used for their easy technique to be manufactured. Commercially accessible insecticides, inorganic nanostructure alumina may furnish a cheap and reliable alternative for control of insect pests.

Nano Herbicide

Weeds are hazard in agricultural production systems. Conventional herbicides are not efficient to remove root system and tubers of weed below the ground. Nanoherbicides can play title role in eliminate weeds from crops in an environment-friendly way, without leaving any unhealthy residues in soil and environment. Target specific herbicide molecule encapsulated with nano particles are aimed for specialized receptors in roots of target weeds, gets tranlocated in parts of weed that inhibit glycolysis of food reserve.

Improved Plant Yield and Quality

Accumulation of carbon-based nanoparticle, fullerol [C60(OH)20] in tissues and cells of root, stem, petiole, leaf, flower and fruit of bitter melon at particular concentrations as the novel factor of rise in biomass yield, fruit yield and phytomedicine content in fruits.

Transgenic Nanovector

Genetic transformation is a major branch of plant biotechnology. Nanobiotechnology provides a new set of aids to maneuver the genes using nanoparticles, nanofibers and nanocapsules. The major benefit of this technique is the concurrent delivery of both DNA and effectors molecules to the targeted sites that results in site specific delivery and expression of chemicals and genes, respectively.

Nanoremediation

Nanoremediation, compared to conventional remediation, offers some advantages, like less time to complete the cleanup process, since the nanoparticles used have more surface area and more reactive. Nanoscale titanium oxide is being examined for the photocatalytic decay of contaminants in air and water. Nanoparticles are good electron donors and have manifested capacity to remediate pesticides.

Recycling of Agricultural Waste by Nanobiotechnology

Scientists are investigating on nanoengineered enzymes that will authorize simple and cost-effective conversion of cellulose from waste plant parts into ethanol. Rice husk is used for biofuel and its burnt byproduct is nanosilica which is utilized in glass and cement industries.

Pros of Nanobiotechnology

- Production of nanomaterials without byproduct.
- Cost effective
- Ecofriendly
- Increase fertilizer, pesticides and herbicide performance and productivity of plant
- Site specific nanoparticles are very effective

Cons of Nanobiotechnology

- Investigation in this field is still at juvenile phase
- Accumulation of nanomaterials in soil and water show cytotoxicity
- Proper knowledge and expertise is required for utilization of nanobiotechniques
- It is curse if some wrong hand use it as bioweapon

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9. PLANT BREEDING

Meiotic Engineering: Controlled recombination for crop improvement

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Meiosis is the essence of Mendelian heredity. It plays key role in successful plant breeding because the reshuffling of homologues and chromosome segments takes place only during meiosis. In meiosis, a single round of DNA synthesis is followed by two rounds of chromosome segregation which leads to reduction in ploidy number (Lambing & Heckmann, 2018). The two crucial events that define meiosis are recombination and ploidy reduction by half. The crucial event in meiosis that leads to create variations is the process of homologous DNA recombination that occurs through DNA double-strand breaks (DSBs) during the stage of prophase I, before the first meiotic division. Breeder rely on this process of natural recombination to generate novel haplotypes. Obligate Cross over (CO) is the minimum number of cross over (CO) per chromosome pair (*i.e.,* 1 CO per chromosome pair) which is required for proper segregation. Plant breeder's interest is therefore, to gain control and modulate this process as per their requirement, to effectively engineer the allelic composition of chromosomes and aid in crop improvement (Taagen *et al.,* 2020).

Meiotic Recombination: Process

- Double-Strand Break Formation
- Double-Strand Break End Processing
- Single-End Invasion
- DSB-Dependent DNA Synthesis
- Holliday Junction Resolution

The process of meiotic recombination involves sequence of events. This process starts

with the formation of double strand breaks (DSBs) that is catalyzed by SPO11 and accessory proteins following which SPO11 remains covalently attached to the DSB ends. Nicking of DSB ends then starts following resection to generate 3′-single-stranded DNA molecules (ssDNAs). This is followed by binding of recombinases RAD51 and DMC1 to the ssDNAs and formation of nucleoprotein filaments that can anneal to the sister chromatid or to a non-sister homologous chromatid to repair the DSBs.

Meiotic Engineering

Meiotic engineering is a process that leads to tinker with the normal (wild type) meiotic mechanism and generate novel allelic combinations. Tickling with the normal meiotic process creates opportunities to extract and fix whole chromosomes from heterozygous complements (*i.e.,* F_1 hybrids).

The process of meiosis can be engineered with different mechanism:

- Controlling crossover (CO)
- Manipulation of CO frequency
- Controlled homologous recombination
- Fine tuning introgression of wild germplasm
- Making diploid gametes
- Enhancing Recombination in heterochromatic regions
- Epigenetic Modifications to Control Recombination

Controlling and manipulating crossover frequency by knocking out CO suppressing genes and thus increasing recombination rate. Homologous recombination can be attained by inducing DSBs (Double strand breaks) in mitotic cells through any of the genome editing approach. Capturing allelic diversity for breeding programmes through introgression of genes from wild relatives is limited due to reduced CO in divergent regions owing to linkage drag. CO can be increased in such regions by manipulating DNA mismatch repair and homologous chromosome pairing mechanisms. Some of the epigenetic modifications like ubiquitination, sumoylation and neddylation can be utilized to increase recombination rate in heterochromatin regions as reported in few crop species.

Efficient induction of recombination events at key genomic position is of great utility for breeders and geneticist. This perturbation of pro- and anti- CO genes and epigenetic modifications by targeting DSBs and utilizing genome editing tools to achieve desirable genetic constitution. These mechanisms can be explored and leveraged for plant breeding to induce novel changes in crop improvement.

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