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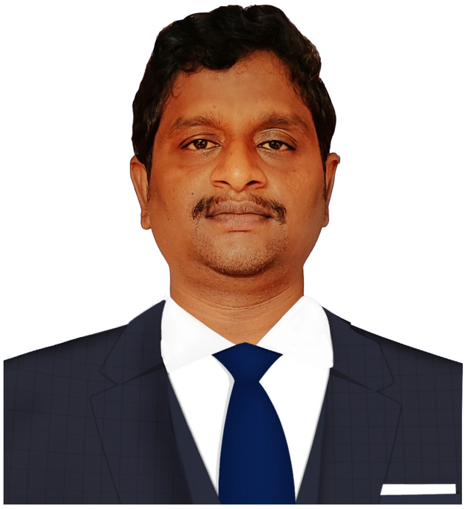
From the Desk of Editor-in-Chief

With immense humbleness and anticipation, I seek it's my pleasure to launch the June 2024 issue of the **"Krishi Netra"** a monthly e-Magazine subtitled "Invisible Vision on Farming" published by **GRN Creatives**. On behalf of the Krishi Netra Editorial Team, I would like to take this opportunity to thank our authors, editors, reviewers and all of them who have volunteered to contribute to the successful release of the first (December) issue of the e-Magazine.



The magazine aims to provide a common platform for the scientific community, research scholars and other readers to publish their ideas, new inventions, research findings etc., to provide the invisible insights for betterment of the farming community. Krishi Netra magazine is primarily focused on the areas of Agriculture, Horticulture, Precision Farming, Fisheries & Animal Sciences, Agriculture Engineering, Agribusiness Management, Food & Dairy Technology, Bio-Sciences/ Life-Sciences, Biotechnology & Biochemistry, Environmental Science &Forestry, Organic Farming, Sericulture and Home Science.

As we turn the pages of Krishi Netra, let us celebrate the unsung heroes, the farmers, the agri-entrepreneurs, the scientists, and the agri scholars. Together, we delve into the realms of sustainable practices, agro ecology, and the transformative power of technology, ensuring that the seeds we sow today yield a bountiful harvest for generations to come.

May this magazine be a source of inspiration, knowledge, and appreciation for the remarkable journey from seed to harvest. Join us on this exploration of the fields that bind us all, as we cultivate a deeper understanding and appreciation for the intricate dance of life on the farm.

I warmly welcome the authors with their contributions that can meet the practical appliances with an integrated/ convergent approach. I wish, with all your support I could see a very bright prospects for Krishi Netra magazine as an eye opener in serving the needs of the farming community.

We look forward for your valuable feedback!
For any questions/ suggestions/ concerns, please contact us: krishinetra@gmail.com
Thank you.

Editor-in-Chief
Gangisetty Srikanth Kumar

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Beyond the Fields: Emotional Labour in Agriculture

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Abstract

Agriculture is often described as physically demanding work. However, for many farm women, the responsibility extends beyond cultivation and livestock care. They manage family emotions, handle financial stress and cope with climate uncertainty. This hidden effort of regulating one's own emotions while supporting others is known as *emotional labour*. It is unpaid and largely unrecognized. Recent global reports highlight that rural women face higher stress due to economic vulnerability, gender inequality, and climate-related risks (FAO, 2023; WHO, 2022). Recognizing emotional labour as part of agricultural work is essential for improving mental well-being, family stability and long-term resilience in rural communities.

Introduction

A farm woman's day begins before sunrise. She prepares meals, organises children's schooling, works in the field, manages livestock and ensures the household runs smoothly. She often handles money matters, arranges inputs, negotiates with traders, and manages care for the elderly and sick all while keeping the household emotionally steady. If crops fail or prices fall, she must remain calm and reassure children and elders, hide worry from others, and still plan for the next season. Farming therefore requires not only physical strength but also emotional endurance. Behind agricultural productivity lies unseen emotional work that is unpaid and rarely acknowledged.

In India, mental health problems are common. About 1 in 10 adults is currently living with a mental health condition that may need care, and nearly 1 in 7 people may experience such a condition at some point in their life (National Mental Health Survey, 2016; WHO, 2022). Recent estimates suggest that around 14% of the population is affected by mental disorders (GBD India, 2023). This burden is also seen in rural and farming communities, where thousands of deaths are reported each year in the agricultural sector (NCRB, 2022). In Telangana, studies have reported around 13% prevalence of antenatal depression in hospital settings, and state data show changing trends in farmer suicides in recent years (Hyderabad antenatal study, 2023; NCRB, 2022). These figures show that the emotional labour carried by farm women is not only a social issue but an important public health concern.

Context: Why Emotional Labour Is High in Agriculture

Climate Stress

Climate change has increased uncertainty in agriculture. Rising temperatures, irregular rainfall, and extreme weather events directly affect income and food security. The FAO (2023) reports that rural women are disproportionately affected by climate shocks because they have fewer economic and institutional resources.

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This uncertainty increases anxiety and emotional pressure within households.

Economic Insecurity

Agricultural income is unstable. Input costs are rising and market prices fluctuate. Financial insecurity is a major contributor to psychological distress in rural communities (World Bank, 2022). Women often manage household expenses and absorb the emotional impact of financial strain.

Gender Roles and Expectations

Women contribute significantly to agricultural labour but often lack formal recognition, land ownership, and decision-making power (UN Women, 2023). They are expected to remain patient and emotionally supportive even during crisis. This creates a double burden: productive labour in fields and emotional caregiving at home.

Social and Care Responsibilities

Women handle childcare, eldercare, food preparation and community participation. These responsibilities add emotional and physical strain.

Key Areas of Emotional Strain

1. Managing Household Emotions

Women comfort children during financial hardship and support family members during stress. They maintain hope during uncertain times.

2. Suppressing Personal Distress

Many women hide their own fears and exhaustion. The WHO (2022) highlights that unaddressed emotional strain can increase the risk of anxiety and depression.

3. Conflict Resolution

Farm women often mediate family disputes and negotiate with traders or local institutions.

4. Continuous Caregiving

Balancing farm work with caregiving duties requires sustained emotional energy.

5. Community Engagement

Participation in Self-Help Groups (SHGs) can provide support but also adds responsibility and leadership expectations.

Impact on Mental Health

Continuous emotional labour without support can result in:

- Chronic fatigue
- Sleep disturbances

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- Irritability
- Feelings of isolation
- Anxiety and depressive symptoms

The WHO (2022) notes that women globally experience higher rates of common mental health conditions due to social and economic stressors. When emotional labour is ignored, mental health risks increase.

Measures and Practical Solutions

A. Personal Level

- Encourage open discussion about stress-Talking about worries reduces emotional burden and prevents isolation.
- Promote relaxation and rest-Simple practices like short breaks, prayer, or breathing exercises help manage daily stress.
- Awareness about mental health services-Knowing where to seek help encourages early support.

B. Family Level

- Share domestic and farm responsibilities-Sharing work reduces overload and emotional exhaustion.
- Involve women in financial decisions-Participation increases confidence and reduces anxiety.
- Recognize and appreciate contributions-Feeling valued improves emotional well-being.

C. Community Level

- Strengthen SHGs as support spaces-SHGs can provide emotional sharing along with financial support.
- Organize mental health awareness programs-Reduces stigma and promotes help-seeking.
- Train frontline workers to identify distress-Early identification prevents severe problems.

D. Policy Level

- Recognize women as farmers-Improves access to schemes and support.
- Integrate mental health into extension services-Combine farming advice with stress awareness.
- Expand crop insurance and financial literacy-Financial security reduces stress.
- Promote gender-sensitive policies-Address workload, land rights, and decision-making gaps (FAO, 2023; UN Women, 2023).

Conclusion

Farm women contribute more than visible labour in agriculture. They carry emotional responsibilities that

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sustain families and communities during crisis. However, this emotional labour often remains invisible. Supporting the mental well-being of farm women strengthens agricultural productivity, family resilience, and rural development. Recognizing emotional labour is not only a matter of fairness it is essential for sustainable agriculture.

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Dentition by Age in Cattle and Buffalo: A Practical Guide for Field Age Determination

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Abstract

Age determination in cattle and buffalo plays an important role in livestock management, especially during purchase, breeding selection, insurance, and legal disputes. Among various methods, dentition examination is the most practical and widely used field technique. Bovines do not possess upper incisors; instead, they have a dental pad. The eruption and replacement pattern of lower incisors provides a reliable indication of age up to four years. After complete eruption of permanent incisors, age estimation is based on wear, spacing, and shape of teeth.

Temporary (milk) incisors erupt within the first few weeks of life and are gradually replaced by permanent incisors between 1.5 to 4 years of age. The sequence of eruption follows a definite pattern: central incisors, first intermediates, second intermediates, and corner incisors. After six years of age, tooth wear becomes noticeable, and by ten years, incisors appear triangular and spaced.

The dentition pattern in cattle and buffalo is largely similar, though buffalo teeth are comparatively broader and darker. Proper understanding of dentition helps veterinarians, farmers, and livestock traders make informed decisions. This article explains the dental formula, eruption pattern, age estimation stages, and practical considerations for accurate age determination in cattle and buffalo under field conditions.

Keywords : Dentition, Age determination, Cattle, Buffalo, Incisors

Introduction

Age estimation is essential in livestock production systems for breeding management, culling decisions, insurance claims, and market valuation. In rural and field conditions, birth records are often unavailable. Therefore, dentition becomes a reliable and cost-effective method for determining the approximate age of cattle and buffalo.

Bovines possess a unique dental arrangement. They lack upper incisors and canines; instead, a tough dental pad is present. Only the lower jaw contains incisors, which are used for age estimation. Understanding the eruption and replacement pattern of these incisors helps in accurate assessment of age, especially up to four years.

Body

Methodology

This article is based on standard veterinary anatomy references, field observations, and practical clinical

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experience. The dentition pattern was evaluated based on:

- Eruption of temporary (deciduous) incisors
- Replacement by permanent incisors
- Wear pattern and morphological changes
- Comparison between cattle and buffalo

The focus is on providing a simple, field-applicable guide.

Results and Discussion

1. Dental Formula of Adult Bovines

Permanent Dental Formula:

2 (I 0/4, C 0/0, PM 3/3, M 3/3) = 32 teeth

Key Points:

- No upper incisors
- No upper or lower canines (lower canine modified as incisor)
- 8 lower incisors used for age determination

2. Temporary (Milk) Incisors

At birth:

- 2–4 temporary incisors may be present

Within 2 weeks:

- All 8 temporary incisors erupt

These milk teeth are small, narrow, and white in appearance. They remain until approximately 1.5–2 years of age.

3. Eruption of Permanent Incisors (Age Estimation)

The replacement follows a definite sequence:

1.5–2 years – First pair (central incisors)
→ Called *Two-tooth stage*

2.5–3 years – Two pairs permanent
→ *Four-tooth stage*

3–3.5 years – Three pairs permanent
→ *Six-tooth stage*

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3.5–4 years – All four pairs permanent
→ *Eight-tooth or Full mouth stage*

Permanent incisors are larger, broader, and slightly yellowish compared to milk teeth.

4. Age Determination After 4 Years (Based on Wear)

After full eruption:

- 5–6 years: Visible wear on central incisors
- 6–7 years: Wear on intermediate incisors
- 8–9 years: Teeth become shorter and spaced
- 10+ years: Teeth appear triangular and worn down
- 12+ years: Teeth may loosen or fall

Accuracy decreases after 8 years due to feeding habits and environmental factors.

5. Difference Between Cattle and Buffalo

The dentition pattern is almost identical in both species. However:

- Buffalo teeth are broader and darker
- Wear may appear slightly slower in buffalo
- Feeding type influences tooth wear significantly

Overall, the eruption timeline remains similar.

Practical Importance

Dentition-based age estimation is useful for:

- Selection of breeding animals
- Purchase and sale verification
- Insurance and compensation cases
- Culling decisions
- Record validation

Veterinarians should combine dentition with physical appearance for better accuracy.

Conclusion : Dentition examination is a simple, economical, and practical method for age determination in cattle and buffalo. The eruption of permanent incisors provides reliable estimation up to four years of age. Beyond this period, wear pattern helps approximate age, though precision decreases with advancing age. Proper knowledge of dental formula, eruption sequence, and wear characteristics is essential for veterinarians,

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livestock inspectors, and farmers to make informed management decisions.

Acknowledgement : The author acknowledges veterinary teachers and field practitioners whose practical insights have contributed to the understanding of age determination techniques.

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Determining plant pathogens virulence factors.

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Abstract

Pathogens like fungus, bacteria, and oomycetes can decrease host immunity, break down cell walls, and alter plant physiology by using virulence factors such effectors, toxins, and enzymes. Cell wall-degrading enzymes in fungi like Fusarium species and type III secretion system effectors in bacteria like *Pseudomonas syringae* are typical examples. Comprehending their functions facilitates the development of specific biocontrols and the breeding of resistant crops. By monitoring host reactions, molecular approaches like RNA-seq, proteomics, genomics, metabolomics, etc., identify potential candidates. CRISPR-Cas9 knockouts and yeast two-hybrid tests are frequently used in functional validation to verify host targets.

Key words: Molecular approaches, pathogens, virulence factors.

Introduction

Understanding virulence factors in plant pathogens involves identifying molecular components like effectors, toxins, enzymes, and adhesion proteins that allow pathogens to evade host defenses, colonize tissues, and cause disease symptoms; virulence is defined as the quantitative degree of host damage rather than just pathogenicity; these factors affect plant cellular processes like gene silencing, MAPK signaling, vesicle trafficking, and hormone pathways; for example, bacterial type III effectors like HopM1 from *Pseudomonas syringae* target ARF-GEF proteins like AtMIN7 to interfere with immunity-related trafficking (Speth *et al*., 2007). Virulence factors, which are frequently provided via type III/IV secretion systems in bacteria or by direct fungal hyphal invasion, enable pathogen adherence, penetration, nutrition acquisition, and suppression of basal defenses such as PAMP-triggered immunity (PTI). Avr factors function as both pathogenicity determinants and recognition targets in gene-for-gene interactions. They evolve quickly by mutations, deletions, or diversifying selection to avoid R proteins, as demonstrated in systems such as rice-*Magnaporthe oryzae* or flax-*Melampsora lini* (Hossain *et al*., 2023). Quantitative real-time PCR (qRT-PCR), which amplifies and quantifies potential virulence genes, such as effectors or toxin biosynthesis loci, from pathogen isolates during host interaction, is one of the molecular tools for identifying virulence factors in plant pathogens (Van Doorn *et al*., 2007). In model plants like *Arabidopsis* or *Nicotiana benthamiana*, gene knockout techniques, such as CRISPR-Cas9 editing and RNA interference (RNAi), disrupt particular virulence genes to evaluate their function in pathogenicity through decreased lesion formation or unsuccessful host colonization.

By amplifying virulence genes such as hrp, pth, and vir from bacterial pathogens or effector genes in fungi, PCR enables direct detection without the need for cultivation. Variants that measure and identify several virulence factors simultaneously in infected tissues include multiplex PCR, nested PCR, and real-time PCR (qPCR). These methods enable high-throughput screening for organisms with certain virulence profiles

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by using primers created from known pathogenicity genes (Haas *et al*., 1995).

Bacterial Virulence Genes

Using particular primers like DXoo_hrp1F and DXoo_hrp1R, the hrp (hypersensitive response and pathogenicity) gene cluster in bacteria like *Xanthomonas oryzae* pv. *oryzae* is amplified, producing a 384 bp product for sensitive detection down to 2.6 x 10^2 CFU/ml in rice seeds and leaves. Similar to this, pathovar-specific primers are used to target pth genes in *Xanthomonas axonopodis* pv. *citri* and vir genes (such as virD2) in *Agrobacterium* spp. for quantitative real-time PCR, identifying pathogenic strains and measuring infection levels.

Fungal Effector Genes

Even at low pathogen loads (1-100 cells), fungal effector genes which increase virulence by inhibiting plant immunity can be identified without culturing by PCR on internal transcribed spacer (ITS) regions or particular effector sequences, frequently from direct tissue samples. In necrotrophic fungi, transcription factors such as PnPf2 control these effectors, and PCR verifies their expression during infection (Jones *et al*., 2019)

By methodically deleting genes in pathogens or hosts, CRISPR-Cas9 allows high-throughput genetic screens to identify those crucial for virulence by tracking changes in infection outcomes. Virulence factors are defined by these tests as genes whose disruption reduces pathogen growth, survival, or host damage. This method has identified bacterial and viral components essential to the development of disease (Zhu *et al*., 2024)

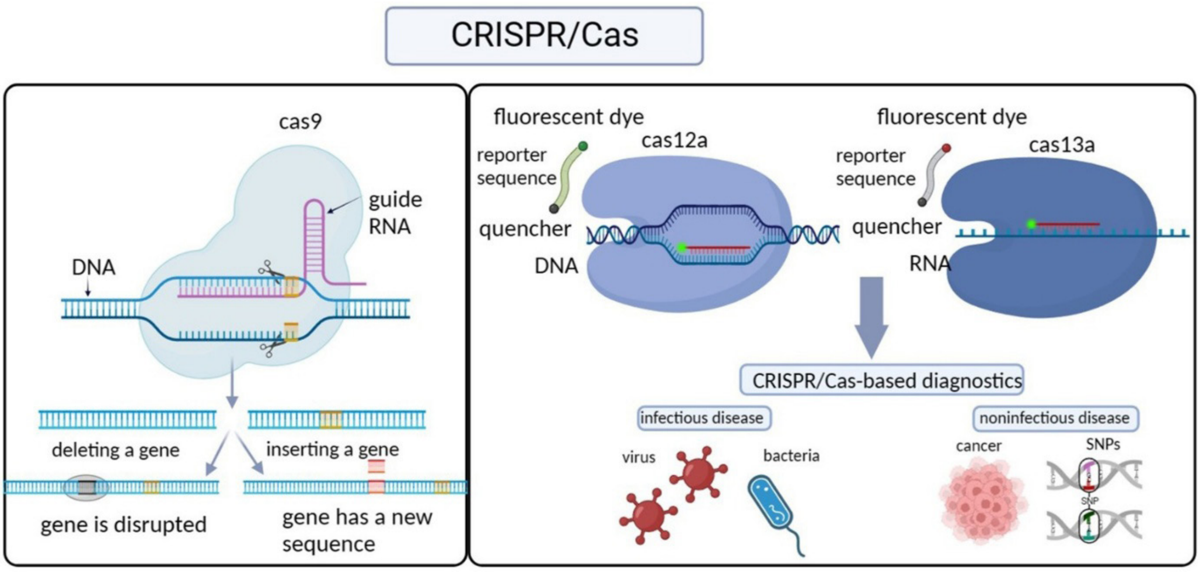

Figure 1: Illustration of CRISPR-Cas sensing mechanisms and their diagnostic application. (Source: Zeng *et al*., 2024)

Under the guidance of sgRNA, CRISPR-Cas9 generates double-strand breaks at particular genomic locations, resulting in insertions or deletions via non-homologous end joining. Editing virulence genes, such as those for effectors, poisons, or cell wall degraders, results in mutants with reduced infection in plant diseases, such as fungi or oomycetes. Phenotypic tests (such as lesion size on host plants) assess gene function, while sequencing confirms edits (Dort *et al*., 2020).

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Hairpin RNA (hpRNA), which generates small interfering RNAs (siRNAs) that target pathogen mRNAs, is expressed in plants by RNAi through host-induced gene silencing (HIGS). During haustorial invasion, these siRNAs enter the pathogen and cleave virulence gene transcripts, such as PtMAPK1 or PtCYC1 in *Puccinia triticina*, lowering their levels by 40–65%. This confirms the roles of genes in host colonization by causing slowed fungal growth, fewer/smaller uredinia (lesions), and up to 79% reduced biomass accumulation in model systems (Panwar *et al*., 2018).

Conclusion

The advancement of disease management techniques in agriculture depends on the identification of virulence factors in plant diseases. Virulence factor identification has been transformed by cutting-edge methods such as metabolomics, genomics, and in planta expression analysis. Targeted breeding for resistant crops and innovative biocontrol agents is informed by an understanding of these networks. Finding strain-specific mechanisms through the integration of CRISPR-Cas9 and multi-omics will open the door to durable disease resistance. Using this information to combat emerging pathogen threats to promotes sustainable agriculture.

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How Scientists are fighting climate change with crops

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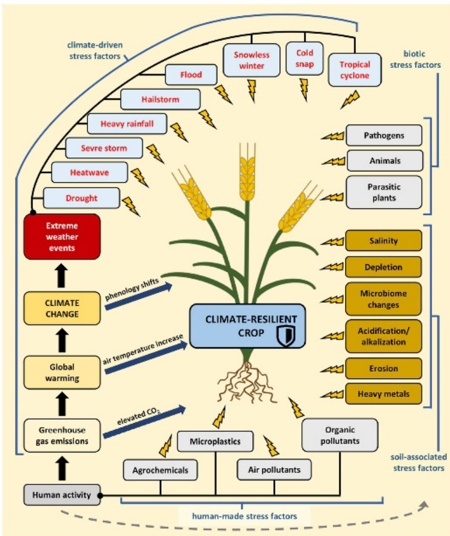
ABSTRACT

Climate change constitutes a growing warning to the global food security, demanding farmers with increasing temperatures, unpredictable rainfall, and increasing pest pressures. In reaction, the scientists across the world are competing to expand crop varieties which are more resilient for these type of increased environmental stresses. By harnessing advanced breeding techniques that include genomic selection, gene editing, and traditional crossbreeding—researchers are enabling the plants that can resist to drought, salinity, extreme heat, and disease outbreaks. These efforts are accompanied by the prevention and utilization of wild crop relatives, which bring the valuable traits lost during domestication. Alterations like CRISPR technology, climate-smart breeding programs, and participatory approaches with local farmers are accelerating progress. Eventually, breeding resilience into crops is not just a scientific challenge; it is a critical plan to safeguard the global food supplies, encouraging rural economies, and build agricultural systems which can adapt to an uncertain future



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INTRODUCTION

In face of mounting environmental challenges, including climate change, emerging diseases, and resource scarcity, the concept of resilience has become a cornerstone of sustainable agriculture. Breeding for resilience refers to the deliberate selection and development of plants and animals that can maintain productivity and healthy under stressful, variable, or unpredictable conditions. Unlike traditional breeding, which often draw attention to maximizing production under optimal conditions, resilience breeding prime

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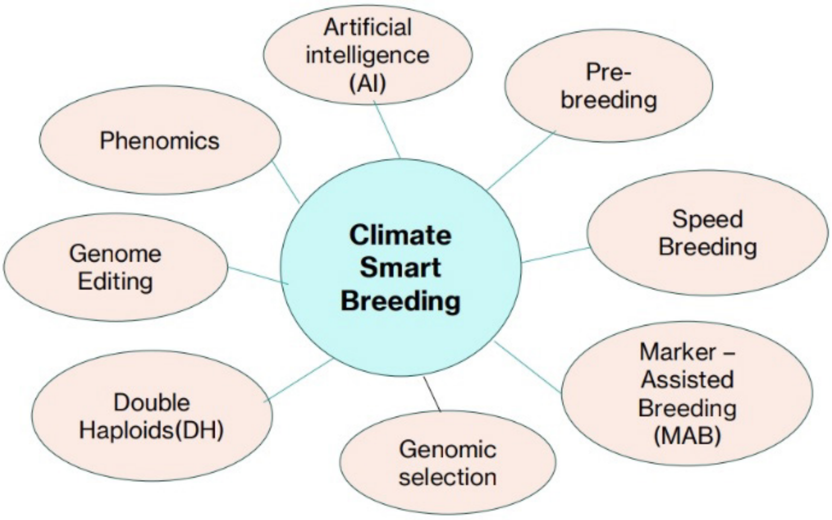
concern stability, adaptability, and robustness across a range of environment.

Breeding for resilience is not just a scientific experimentation- it is judicious response to ensure food security, economics firmness for farmers and environmental sustainability. As agriculture enters a new generation of uncertainty, resilience breeding stands out as a proactive and necessary tool for adapting to the future.

Various smart breeding approaches for climate resilient agriculture



Pre-breeding serves as a important bridge between the plant genetic resources (gene banks) and the conventional breeding programs. It recognises the valuable traits or genes in unadjusted materials that cannot be directly included into the breeding populations. These traits are then shifted to the intermediate materials to make them acceptable for further breeding efforts. Pre-breeding marks several censorious challenges that include the restricted genetic diversity in modern agriculture, genetic uniformity, and the collision of climate change on crop adaptation. Crop wild relatives (CWRs) often play a vital role in pre-breeding efforts, as they allow the breeders to separate valuable traits and introduce them into elite varieties more readily.

Speed Breeding

Speed breeding surround a suite of techniques that are planned to advanced generation cycles in crops. By operating the environmental conditions like light, temperature, and soil moisture. Researchers can quicken the flowering and seed set, decreasing the time required for the next breeding generation. Speed breeding consequently shortens generation time and accelerates breeding and research programs. It appears for a valuable tool for expanding climate-resilient crops capable of resist to shifting climate patterns and high weather events.

Marker-Assisted Breeding (MAB)

MAB transforms the breeding process by using DNA markers connected with desirable traits to select plants for inclusion in the breeding programs at an early stage of development. This technique smoothens the recognition of varieties expressing desired traits, decreasing the time needed for variety development. MAB includes Marker-Assisted Backcrossing (MABC), Marker-Assisted Gene Pyramiding (MAGP), and other approaches, enabling breeders to intensively stack multiple traits into elite varieties.

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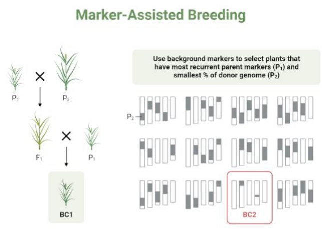

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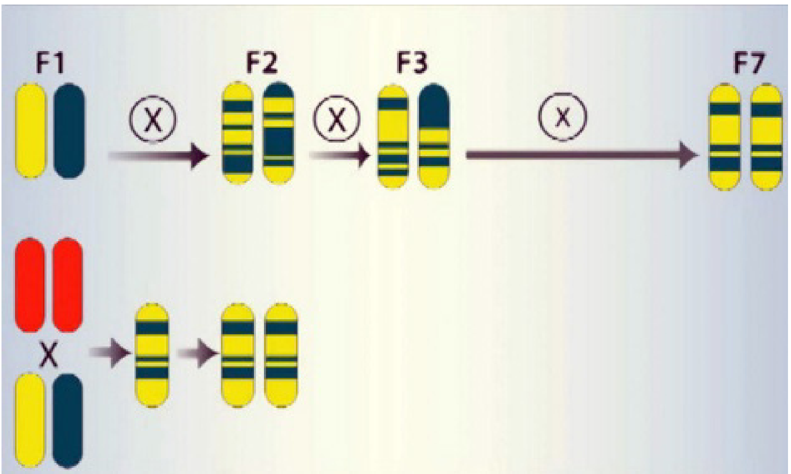
Genomic Selection

Genomic selection refers a breeding methodology given by Hayes and Goddard in 2001. It includes two distinct populations: training population and breeding population. A training population, that is a genotyped for many markers and phenotype for vital traits, and a breeding population, consisting of genotyped but not phenotype individuals. Genomic selection depends on a prediction model to evaluate breeding values derived from marker effects. This methodology sanctions more intensive selection of candidates for the next breeding cycle, reducing both the cost and time required for variety development. Genomic selection is a high powered tool in evolving climate-resilient crop varieties.

Double Haploids (DH)

DH technology give rise to homozygous lines by doubling the chromosomes of haploid plants produced from either egg or sperm cells. Two largely used technologies for DH production are microspore culture and anther culture, both of which have clear advantages. DH technology attains complete homozygosity in a single generation, importantly shortening the time needed for developing the pure lines. This approach provides many advantages, including more accurate phenotyping, accurate gene-trait relation to genetic mapping, and accelerated gene function studies.



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Gene editing methods, such as CRISPR/Cas9, provide a high powered means of manufacturing accurate modifications to DNA at the specific genomic locations. This method allows for the formation of gene knockouts or knockdowns without the permanent introduction of foreign DNA. Genome editing holds the notable potential for mitigating the collision of climate change by increasing the crop resilience.

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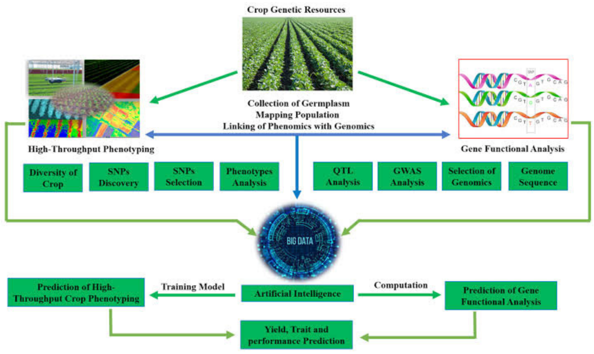
1. Phenomics

Phenomics involves the systematic course of phenotypes, which are the noticeable physical features of plants. Advanced phenotyping methods namely- three-dimensional imaging, infrared imaging, and fluorescence imaging, that enable quick and large assessments of plant traits. High-throughput phenotyping accelerates plant breeding by encouraging the screening of thousands of plants fastly. This approach increases the selection of individuals with the desired traits and advances the development of climate-resilient crop varieties.

Artificial intelligence (AI):

Artificial intelligence (AI) is transforming the plant breeding by expediting the enlargement of superior crop varieties. AI holds the data analysis and the predictive modelling to enhance breeding programs. Genomic forecast and selection use of AI to quickly recognise the plants with desired traits, decreasing traditional breeding timelines. Marker-assisted breeding (MAB) benefits from AI's capability to discover and validate molecular markers connected to specific traits. AI-driven technologies, like remote sensing and hyperspectral imaging, enable accurate and non-destructive phenotyping. Moreover, AI improves breeding program designs, manages data, predicts disease and pest outbreaks, and aids in genome editing. In a world of facing food security and climate change challenges, AI authorises breeders to create resilient, high-yielding crop varieties efficiently.



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CONCLUSION

In conclusion, scientists are controlling the ability of breeding resilience to expand crops and livestock that can thrive under at most and uncertain conditions. By using up to date tools like genetic engineering, market assisted selection, and climate- smart breeding methods, they are generating species that can resistant to drought, heat, floods and emerging pests. This inventive approach not only saves the global food supplies but also permit farmers to modify to a rapidly changing world, making breeding resilience in cornerstone in the fight against climate change.

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Growing Hope : The Story of Improved Seeds

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Introduction:

Every seed has the power to change the world

Seed is a fundamental input in crop farming. It has played a critical role in agricultural development since humans domesticated the crop around 11,000 years ago. It is a carrier of genetic information that controls the maximum crop productivity, resistance to disease, tolerant to environmental stresses such as drought.

By using quality seeds that can withstand pests and diseases and adapt to different environments, farmers can improve food production, ensure food security, and boost economic growth for their communities. This approach focuses not only on growing more crops but also on creating a better future for people around the world. In 2020-21, agriculture contributed 20.2% to India's GDP and employed over 50% of the workforce.


Role of improved seed

Improved seeds offer a significant increase in yield potential and are an economical input, as demonstrated during the Green Revolution. However, Indian agricultural sector has an important opportunity to further develop the seed production sector. Generation and transfer of new technologies are essential for agricultural development .especially that of improved varieties, is an essential input for increasing crop productivity.

Seeds of improved varieties are regarded as effective tools in enhancing crop productivity since it dramatically changed the productivity of crops during the Green Revolution of the 1960s to 1980s.

Transforming lives and communities

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Improved seeds offer a ripple effect beyond increased yield for individual farmers, boosting household incomes through surplus crop sales, leading to investments in education, healthcare, and better farming equipment. In developing regions, this access to improved seeds fuels the development of vibrant agricultural communities and empowers farmers, especially women, to become leaders in advocating for sustainable practices and sharing knowledge.

The part played by improved seed

. Plant breeding work in India is scarcely forty-five years old .During thirty years, the crop breeders have to their credit several new varieties in all the major crops like rice, cotton, millets and oilseeds. Many of these improved varieties released for cultivation were the outcome of straight selection made in cultivators' bulk or in crosses effected between closely related varieties. They have solved to a very limited extent the problems of diseases, pests, duration, drought, lodging. Quality and yield of finished produce. Most of the varieties judged from their respective area spread, must be deemed to possess only a limited adaptability. The full advantages of improved strains are very often not realised on account of the limitations in the quantities of pure seed produced for distribution by the Department ieaving the bulk of the adaptive area to natural spread having a purity range of 60 to 95 percent. Such a state of affairs is beset with two drawbacks vex., (1) The increases in production will be more or less roughly proportional to the purity grade of the variety grown and (2) The fall in production will be in geometrical proportion to the impurity in the seed material used for successive plantings. An all-out effort made in covering the entire adaptive zones with pure seeds will therefore help in increasing the production per unit area proportionate to the impurity found in seeds used for sowing by cultivators.

The official estimates of area spread of improved varie-ties place rice at 48%, cotton at 50%, sugarcane at 95% and millets and oilseeds at 10% of the respective annual areas. Notwithstanding the large spread of rice and sugarcane, the normal outturns per acre figuring in the Season and Crop reports have remained more or less stationary. It should however be interpreted as an indirect tribute to the new varieties which have helped to maintain the normal yields in spite of extension of cultivation to new areas, the seasonal losses resulting from unkind weather and damage by pests and diseases. The normal yields of cotton which were 250 lb. for irrigated and 35 to 54 lb. for unirrigated areas in the districts of Coimbatore, Salem and Tiruchirappalli in the year 1921-1922, have been revised to the higher figures of 300 lb. for irrigated and 85 to 125 lb. for unirrigated cotton. In this connection, it will be worthwhile to review the trends seen in the crop-cutting experiments on rice in Madras conduc-ted during 1948-1949. The estimates as per sampling method were (a) 39% of rice was under improved strains, which in turn gave 30% increased yield over the cultivators' bulk (b) the total production of the State was higher than the official figures adopted in the Season and Crop reports by 5% and (c) the productive capacity of the Departmental strains registered further increases up to 33% when associated with manures. There was one definite indication in these crop-cutting trials. Improved strains of rice were noticed to respond invariably well under conditions of high fertility. It would therefore appear that a great portion of our present deficit could be reduced by undertaking an intensive mannrial campaign in areas where our strains have largely spread.

Conclusion

The story of improved seed is a story still being written. Every season, as farmers sow these seeds, they are

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planting more than crops-they are planting dreams, stability, and a future for the next generation. Through collaboration, innovation, and a shared commitment to sustainability, the world can continue to grow hope from the soil up.

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Innovative Techniques in Mulberry Silkworm Rearing for Enhancing the Productivity and Profitability in Sericulture

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ABSTRACT

Sericulture, the art of raising silkworms for silk production, is a vital agro-based industry, particularly in many developing economies. Traditional silkworm rearing practices, while effective, often face challenges related to disease susceptibility, labour intensity, environmental control, and feed efficiency, impacting overall productivity and silk quality. Silkworm rearing has been a cornerstone of the sericulture industry for centuries, but with the advent of modern technology and scientific advancements, there is an increasing push to improve the efficiency, sustainability, and overall productivity of this process. Innovative techniques in silkworm rearing are essential to meet the growing demands for silk while minimizing the environmental impact. This paper explores cutting-edge methodologies and technologies that are revolutionizing silkworm farming, including the use of artificial intelligence and machine learning for optimizing breeding and environmental conditions, genetic improvements through biotechnological interventions, and the integration of automated systems for monitoring and management. Technology such as gene therapy, gene editing, nano-biotechnology, transgenic technology and fortififying mulberry leaves with food additives, climate controlled rearing systems and digital monitorings provide real-time surveillance of silkworm health and environmental conditions. By incorporating these advancements, the silkworm rearing industry can not only increase yield and quality but also contribute to global sustainability efforts. Innovation has come up as technological solution to the sericulture problems along with being easy to learn, maintain and being cost effective. The aim of this paper is to present a comprehensive overview of these innovative techniques and their potential to transform the future of silkworm rearing.

Keywords*: Sericulture, Innovations, Silk, Technology, Sustainability*

I. Innovative Technological Interventions in Sericulture

A. Automated Silk Reeling Machines

Automated machines used to silk reeling process from cocoons, improving efficiency to minimal material waste and enhances production efficiency consistency of thread quality, ensures superior thread uniformity and higher silk quality.

B. Climate Controlled Rearing Houses

These houses regulate temperature, humidity, and ventilation to optimize the rearing environmental conditions and produces more consistent and higher-quality of silk, to minimise risk of diseases and improves silkworm production.

C. Digital Monitoring Systems/ Precision farming techniques

In sericulture, Precision farming techniques involve the use of tools like GPS, data analytics and remote sensing to manage silkworm cultivation. Remote sensing tools such as drones and sensors to monitor silkworm health, feed and environmental conditions, climate control and disease management. These

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techniques ensures that silkworms receive the exact conditions they need to survive and improving both the quality and quantity of the silk.

D. **Artificial intelligence in sericulture**

The application of Artificial Intelligence (AI) in sericulture enhancing efficiency, productivity, quality of silk. AI-powered image recognition systems can detect early signs of diseases or pest infestation and also analyse environmental data such as temperature, humidity, and light levels to optimize conditions for silkworm growth and cocoon production. Automated systems powered by AI manage the cleaning and feeding processes, reducing labour costs and human error while maintaining optimum conditions for the silkworms. These advancements contribute to higher efficiency, lower costs and minimize waste, ultimately enhance the sustainability practices of sericulture.

II. Genetic advancements in silkworm development

High-Yield Silkworm Varieties

Quality enhancement through breeding enhancing larger quantities of silk ensures higher silk output and consistency and maintains or improves fibre quality. Genetic modifications breeder scientists are able to select and propagate silkworms with specific genetic advances that lead to, elasticity of silk. Higher silk yield, improves fibre health, strength and disease resistance.

III. Sustainable approaches in sericulture

A. **Integrated Pest Management (IPM)**

Biological controls strategies like release of natural predators, parasitoid to instead use of synthetic pesticides. To enhances silk quality, consistence by avoiding chemical pesticide residues.

B. **Recycling and Waste Reduction**

Recycling sericulture waste techniques, such as using mulberry leaves as compost. It lowers costs of production and promotes sustainability of sericulture. While it has little direct effect on silk quality, it significantly promotes environmental sustainability.

IV. Biotechnology in sericulture

A. **Silk Protein Engineering**

Tailoring silk proteins for specific properties like biocompatibility or enhanced quality and strength. Diversifies applications in industries beyond textiles and produces silk with superior properties for specialized uses.

B. **Genetic modification of silkworms**

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To produce recombinant proteins or other valuable substances in sericulture, it helps to built new commercial opportunities in pharmaceuticals and biotechnology and also expands the functional uses of silk beyond traditional applications.

C. Silk-Based Biomaterials

Development and production of silk is use in medical and industrial biomaterials, such as tissue engineering and implants. Silk industry creates high-value, specialized qualities of silk products.

V. Economic and social impact of innovations in sericulture

Advancements in sericulture have greatly influenced the social and economic conditions of silk farming. The use of modern technology, the creation of genetically enhanced silkworms, and the implementation of eco-friendly methods are crucial for maintaining the long-term viability and success of the silk industry, the application of biotechnology in sericulture is opening new avenues for research and commercialization, expanding the potential uses of silk beyond textiles.

A. Empowering Rural Communities and Women Empowerment

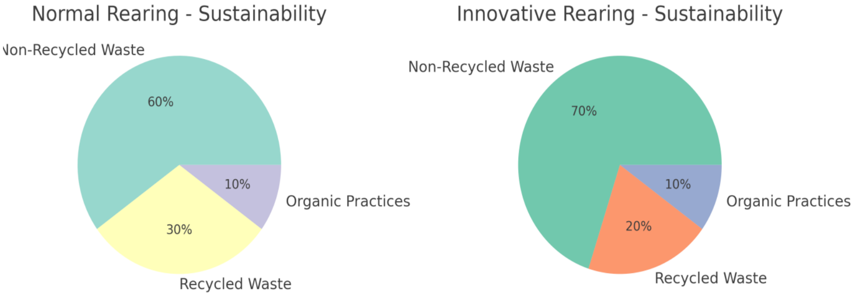
Sericulture is a stable income source for rural people enhanced by modern techniques and it results increased productivity, profitability, sustainable livelihood and rural development. Sericulture often practiced by women, with recent advancements techniques provides better income and opportunities. It enhances economic status and social standing of rural people.

B. Global Silk Market Competitiveness

The continuous advancements in sericulture have significantly enhanced the global competitiveness of the silk industry. Improvements in silk quality, production efficiency, and technological innovation have enabled silk-producing countries to strengthen their position in the international market.

Conclusion

Innovative silk rearing techniques are transformed in the sericulture industry by improving silk yield, quality, and sustainability through automation, AI, and biotechnology. These advancements reduce costs, control diseases, and promote eco-friendly practices while empowering rural communities. Overall, they enhance productivity, profitability, and global competitiveness of the silk industry.



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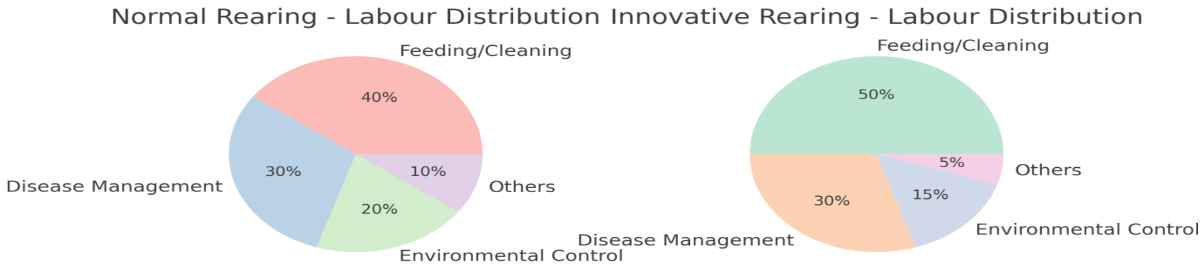
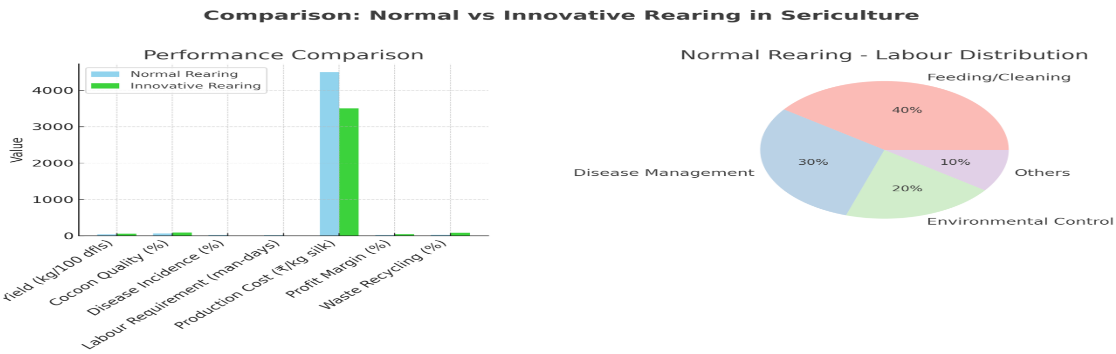
Comparison Overview: Normal vs. Innovative Rearing Technique





Parameter	Normal Rearing	Innovative Rearing	Improvement (%)
Silk Yield (kg/100 dfls)	40	60	+50%
Cocoon Quality (% superior grade)	65	90	+38%
Disease Incidence (%)	25	8	–68%
Labour Requirement (man-days/100 dfls)	20	12	–40%
Production Cost (₹/kg silk)	4500	3500	–22%
Profit Margin (%)	25	45	+80%
Waste Recycling/Utilization (%)	30	85	+183%
Sustainability Index (qualitative)	Low	High	—

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Integration of Ai And Iot In Modern Farming

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ABSTRACT

Agriculture is undergoing a remarkable digital transformation with the introduction of Artificial Intelligence (AI) and the Internet of Things (IoT). These advanced technologies are not only improving productivity but also making farming more precise, predictable, and environmentally sustainable. IoT devices collect continuous, real-time data from fields, livestock, and machinery, while AI analyzes this data to generate insights, predictions, and automated decisions. Together, they create smart farming systems that help farmers reduce waste, improve crop quality, and make informed decisions. This article explores how AI and IoT work individually and in combination, their applications in modern agriculture, benefits, challenges, and future prospects.

INTRODUCTION

Farming has traditionally depended on manual labor, observation, and experience. However, growing global food demand, climate change, and resource limitations have led to the need for more efficient and sustainable farming practices. The integration of AI and IoT offers new opportunities by transforming farms into highly responsive, data-driven environments. Through sensors, drones, smart machinery, and intelligent algorithms, farmers can now monitor every aspect of their fields and respond to issues instantly. This shift marks an important evolution from traditional to smart agriculture.

IoT in Modern Farming: Creating Connected Farms

IoT (Internet of Things) acts as the sensory system of modern farms. By placing smart sensors and devices across the field, farmers can gather real-time data without the need to physically inspect each part of the land.

IoT technologies commonly used in agriculture include:

- **Soil Sensors**: These monitor moisture, pH levels, nutrient content, and temperature, helping farmers know exactly when to irrigate or fertilize.
- **Weather Stations**: They track rainfall, wind speed, humidity, and temperature, providing accurate microclimate information.
- **Smart Irrigation Systems**: These automatically water crops based on soil moisture data.
- **Drones**: Equipped with cameras and thermal sensors, drones capture aerial images and detect plant stress.
- **Livestock Monitoring Devices**: Wearables track animal health, movement, and fertility cycles.

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Through IoT, farms become “digitally aware,” enabling farmers to make quicker and more informed decisions.

AI in Modern Farming: The Intelligence Behind Decisions

While IoT gathers data, AI analyzes it—making it the brain of smart farming. AI technologies help farmers interpret complex patterns that would be difficult or impossible for humans to detect manually.

Key AI applications include:

- **Machine Learning Algorithms**: Used to predict crop yields, identify diseases, and assess optimal planting practices.
- **Computer Vision**: Drones and cameras use AI to detect pests, nutrient deficiencies, and weed growth by analyzing images.
- **Smart Machinery and Robotics**: Robots assist with harvesting, weed removal, and seeding with high precision.
- **Predictive Models**: AI forecasts weather changes, disease outbreaks, and market trends, helping farmers plan ahead.

AI turns raw data into actionable insights, reducing guesswork and improving decision-making accuracy.

How AI and IoT Complement Each Other

The true impact of technology emerges when AI and IoT operate together. IoT collects continuous data, and AI processes it to make intelligent suggestions or automate actions. This integration creates a cycle of monitoring, analysis, and optimization.

Precision Agriculture

Precision agriculture focuses on delivering the right amount of water, fertilizer, and pesticides at the right time.

- IoT sensors collect real-time soil and plant data.
- AI analyzes the data to determine plant needs.
- Farmers or automated systems take targeted actions.

This approach reduces resource waste and enhances crop health.

Smart Irrigation

Smart irrigation systems are among the most impactful innovations:

- Sensors measure soil moisture levels.
- AI predicts future water requirements based on weather and crop growth.

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- Automated systems irrigate only when necessary.

This prevents overwatering, conserves water, and ensures healthier crops.

Crop Health Monitoring

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Drones combined with AI-powered image analysis can detect early signs of disease, pest infestation, or nutrient deficiencies.

Farmers receive instant alerts on their devices, allowing them to intervene before issues spread. This leads to healthier crops and reduced use of harmful chemicals.

Predictive Analytics for Better Planning

By studying historical and real-time data, AI predicts:

- Weather changes
- Potential disease outbreaks
- Ideal planting and harvesting periods
- Market demand fluctuations

These predictions help farmers minimize risk, avoid losses, and maximize productivity.

Livestock Management

IoT wearables track animal temperature, activity levels, and health indicators.

AI analyzes this information to:

- Detect illness early
- Monitor fertility cycles
- Improve feeding routines
- Increase milk or meat production

This leads to healthier livestock and reduced mortality.

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Benefits of Integrating AI and IoT in Farming

The combined use of these technologies results in several advantages:

- **Increased Crop Yield**: Better monitoring leads to healthier, more productive plants.
- **Resource Efficiency**: Water, fertilizers, and pesticides are used precisely.
- **Reduced Labor Costs**: Automation reduces manual work.
- **Real-Time Decision Making**: Farmers can respond quickly to problems.
- **Environmental Sustainability:** Lower chemical usage and better water management reduce environmental impact.
- **Improved Quality**: Crops grow under ideal conditions, increasing quality and consistency.

Challenges and Limitations

Despite the benefits, the integration of AI and IoT faces several challenges:

- **High Initial Costs**: Devices, sensors, and AI systems can be expensive.
- **Technical Skill Requirement**: Farmers need training to use these technologies effectively.
- **Connectivity Issues**: Rural areas often lack strong internet access.
- **Data Security Risks**: Handling sensitive farm data requires strong cybersecurity measures.

Future Prospects

The future of farming is expected to be even more advanced with innovations such as:

- **Fully Autonomous Farms**: Robots and AI systems performing all tasks from planting to harvesting.
- **Blockchain Integration**: Ensuring transparency and traceability in food supply chains.
- **Edge AI**: Processing data directly on local devices without relying on the cloud.
- **Digital Twin Farms**: Virtual replicas of farms used to test farming strategies before implementing them.

These advancements will further improve farm efficiency and sustainability.

Conclusion

The integration of AI and IoT in modern farming is revolutionizing agriculture by making it more precise, efficient, and sustainable. IoT provides continuous, real-time information from fields and livestock, while AI transforms this data into valuable insights and automated actions. Together, they enable farmers to make informed

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decisions, reduce resource waste, and improve productivity. Although challenges such as cost and connectivity remain, the benefits far outweigh the limitations. As these technologies continue to evolve, smart farming will play a crucial role in feeding the growing global population while protecting the environment.

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Beyond the Fields: Emotional Labour in Agriculture

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Abstract

Agriculture is often described as physically demanding work. However, for many farm women, the responsibility extends beyond cultivation and livestock care. They manage family emotions, handle financial stress and cope with climate uncertainty. This hidden effort of regulating one's own emotions while supporting others is known as *emotional labour*. It is unpaid and largely unrecognized. Recent global reports highlight that rural women face higher stress due to economic vulnerability, gender inequality, and climate-related risks (FAO, 2023; WHO, 2022). Recognizing emotional labour as part of agricultural work is essential for improving mental well-being, family stability and long-term resilience in rural communities.

Introduction

A farm woman's day begins before sunrise. She prepares meals, organises children's schooling, works in the field, manages livestock and ensures the household runs smoothly. She often handles money matters, arranges inputs, negotiates with traders, and manages care for the elderly and sick all while keeping the household emotionally steady. If crops fail or prices fall, she must remain calm and reassure children and elders, hide worry from others, and still plan for the next season. Farming therefore requires not only physical strength but also emotional endurance. Behind agricultural productivity lies unseen emotional work that is unpaid and rarely acknowledged.

In India, mental health problems are common. About 1 in 10 adults is currently living with a mental health condition that may need care, and nearly 1 in 7 people may experience such a condition at some point in their life (National Mental Health Survey, 2016; WHO, 2022). Recent estimates suggest that around 14% of the population is affected by mental disorders (GBD India, 2023). This burden is also seen in rural and farming communities, where thousands of deaths are reported each year in the agricultural sector (NCRB, 2022). In Telangana, studies have reported around 13% prevalence of antenatal depression in hospital settings, and state data show changing trends in farmer suicides in recent years (Hyderabad antenatal study, 2023; NCRB, 2022). These figures show that the emotional labour carried by farm women is not only a social issue but an important public health concern.

Context: Why Emotional Labour Is High in Agriculture

Climate Stress

Climate change has increased uncertainty in agriculture. Rising temperatures, irregular rainfall, and extreme weather events directly affect income and food security. The FAO (2023) reports that rural women are disproportionately affected by climate shocks because they have fewer economic and institutional resources. This uncertainty increases anxiety and emotional pressure within households.

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Economic Insecurity

Agricultural income is unstable. Input costs are rising and market prices fluctuate. Financial insecurity is a major contributor to psychological distress in rural communities (World Bank, 2022). Women often manage household expenses and absorb the emotional impact of financial strain.

Gender Roles and Expectations

Women contribute significantly to agricultural labour but often lack formal recognition, land ownership, and decision-making power (UN Women, 2023). They are expected to remain patient and emotionally supportive even during crisis. This creates a double burden: productive labour in fields and emotional caregiving at home.

Social and Care Responsibilities

Women handle childcare, eldercare, food preparation and community participation. These responsibilities add emotional and physical strain.

Key Areas of Emotional Strain

1. Managing Household Emotions

Women comfort children during financial hardship and support family members during stress. They maintain hope during uncertain times.

2. Suppressing Personal Distress

Many women hide their own fears and exhaustion. The WHO (2022) highlights that unaddressed emotional strain can increase the risk of anxiety and depression.

3. Conflict Resolution

Farm women often mediate family disputes and negotiate with traders or local institutions.

4. Continuous Caregiving

Balancing farm work with caregiving duties requires sustained emotional energy.

5. Community Engagement

Participation in Self-Help Groups (SHGs) can provide support but also adds responsibility and leadership expectations.

Impact on Mental Health

Continuous emotional labour without support can result in:

- Chronic fatigue
- Sleep disturbances
- Irritability

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- Feelings of isolation
- Anxiety and depressive symptoms

The WHO (2022) notes that women globally experience higher rates of common mental health conditions due to social and economic stressors. When emotional labour is ignored, mental health risks increase.

Measures and Practical Solutions

A. Personal Level

- Encourage open discussion about stress-Talking about worries reduces emotional burden and prevents isolation.
- Promote relaxation and rest-Simple practices like short breaks, prayer, or breathing exercises help manage daily stress.
- Awareness about mental health services-Knowing where to seek help encourages early support.

B. Family Level

- Share domestic and farm responsibilities-Sharing work reduces overload and emotional exhaustion.
- Involve women in financial decisions-Participation increases confidence and reduces anxiety.
- Recognize and appreciate contributions-Feeling valued improves emotional well-being.

C. Community Level

- Strengthen SHGs as support spaces-SHGs can provide emotional sharing along with financial support.
- Organize mental health awareness programs-Reduces stigma and promotes help-seeking.
- Train frontline workers to identify distress-Early identification prevents severe problems.

D. Policy Level

- Recognize women as farmers-Improves access to schemes and support.
- Integrate mental health into extension services-Combine farming advice with stress awareness.
- Expand crop insurance and financial literacy-Financial security reduces stress.
- Promote gender-sensitive policies-Address workload, land rights, and decision-making gaps (FAO, 2023; UN Women, 2023).

Conclusion

Farm women contribute more than visible labour in agriculture. They carry emotional responsibilities that sustain families and communities during crisis. However, this emotional labour often remains invisible. Sup-

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porting the mental well-being of farm women strengthens agricultural productivity, family resilience, and rural development. Recognizing emotional labour is not only a matter of fairness it is essential for sustainable agriculture.

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Harnessing Biopesticides for Sustainable Agriculture

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Abstract

Biopesticides, derived from natural microorganisms, plants and biochemicals provide a safer, targeted alternative to chemical pesticides amid growing concerns over environmental and health impacts. This article explores their types—including microbial (e.g., *Bacillus thuringiensis*), botanical (e.g., neem), biochemical and genetically modified variants plus key benefits like low toxicity, reduced pest resistance, organic farming support, improved crop quality/yield and enhanced biodiversity. Contrasting them with chemical options, it details short and long term effects such as cost savings and resilient ecosystems, while forecasting biotechnology driven growth for sustainable agriculture.

Introduction

In recent years, biopesticides have gained significant attention due to their environmental friendliness, low toxicity and ability to target specific pests. They provide an eco-friendly approach to pest and disease management, contributing to more sustainable agricultural practices.

Types of biopesticides

Biopesticides can be classified into different types based on their source and method of action:

1. **Microbial biopesticides**: These are made from living microorganisms such as bacteria, fungi or viruses. Examples include *Bacillus thuringiensis* (Bt) and *Beauveria bassiana*. Microbial biopesticides are highly specific and have low toxicity to non-target organisms, making them a safer alternative to chemical pesticides.

2. **Botanical biopesticides**: Derived from plant extracts, botanical biopesticides include neem, pyrethrum and tobacco. These biopesticides are biodegradable and decompose quickly in the environment, causing less long-term damage compared to synthetic chemicals.

3. **Biochemical biopesticides**: These are natural substances like plant extracts or fermentation products. Examples include neem extracts and pyrethrins, which disrupt pests' physiological processes and offer an environmentally friendly pest control solution. Biopesticide formulations for insect pest management.

4. **Genetically Modified (GM) biopesticides**: GM biopesticides are developed through genetic engineering to enhance their effectiveness. These biopesticides can be tailored to target specific pests, providing more precise pest control while reducing environmental impacts.

Benefits of Biopesticides in Modern Agriculture

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1. **Environmental safety**: Unlike chemical pesticides, biopesticides do not leave toxic residues in soil or water, minimizing pollution and harm to ecosystems. They also reduce the impact on beneficial insects and other non-target organisms.

2. **Targeted pest control**: Biopesticides are highly effective at targeting specific pests or diseases. This targeted approach reduces the risk of harming non-pest organisms, such as pollinators and natural pest predators, which are essential for maintaining biodiversity.

3. **Reduced risk of resistance**: Unlike chemical pesticides, which often lead to resistance over time, biopesticides work through different modes of action. This lowers the risk of pests developing resistance, ensuring their effectiveness for longer periods.

4. **Support for organic farming**: Biopesticides are particularly valuable in organic farming, where the use of synthetic pesticides is restricted. They help maintain healthy crops without relying on harmful chemicals, contributing to more sustainable agricultural practices.

Impact on crop quality and yield

1. **Improved crop quality**: Chemical pesticides can sometimes reduce crop quality by leaving harmful residues. In contrast, biopesticides improve the quality of crops by controlling pests and diseases without compromising taste, appearance or nutritional value.

2. **Increased crop yield**: Biopesticides help prevent pest and disease damage, leading to healthier crops and improved yields. Their use promotes more consistent and productive farming practices.

Comparison with chemical pesticides

1. **Environmental impact**: Chemical pesticides often contribute to soil degradation, water contamination, and harm to non-target organisms. Biopesticides, on the other hand, offer a more environmentally friendly option by targeting only specific pests and minimizing broader ecological impacts.

2. **Pest resistance**: The rapid development of resistance to chemical pesticides is a significant concern. Biopesticides, however, work in ways that are less likely to foster resistance, making them a more sustainable long-term solution for pest control.

Short-Term and Long-Term Effects

1. **Short-term effects**:
    - Effective pest control that leads to increased crop yield and quality.
    - Reduced dependence on synthetic chemical pesticides, reducing pollution and health risks.
    - Enhanced soil health and conservation of beneficial organisms, supporting biodiversity.

2. **Long-term effects**:
    - Reduced risk of pesticide resistance, ensuring sustainable pest management over time.
    - Improved soil health, water quality, and biodiversity, promoting more resilient agricultural

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ecosystems.

- Lower long-term pest control costs as biopesticides offer sustainable and effective alternatives to synthetic chemicals.

Future outlook: The use of biopesticides in agriculture is expected to grow as awareness increases about the negative effects of chemical pesticides on human health and the environment. Advances in biotechnology and genetic engineering will likely lead to the development of new, more effective biopesticides. These innovations will help biopesticides become more targeted, environmentally resistant, and adaptable to various agricultural needs.

Conclusion: Biopesticides offer a promising and sustainable solution for pest management in modern agriculture. They provide an effective alternative to chemical pesticides, improving crop quality and yields while safeguarding the environment. With continued research and development, biopesticides are set to play an even larger role in shaping the future of sustainable agriculture. Their integration into farming practices will contribute to healthier ecosystems and promote more eco-friendly, resilient agricultural systems.

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Determining plant pathogens virulence factors.

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Abstract

Pathogens like fungus, bacteria, and oomycetes can decrease host immunity, break down cell walls, and alter plant physiology by using virulence factors such effectors, toxins, and enzymes. Cell wall-degrading enzymes in fungi like Fusarium species and type III secretion system effectors in bacteria like *Pseudomonas syringae* are typical examples. Comprehending their functions facilitates the development of specific biocontrols and the breeding of resistant crops. By monitoring host reactions, molecular approaches like RNA-seq, proteomics, genomics, metabolomics, etc., identify potential candidates. CRISPR-Cas9 knockouts and yeast two-hybrid tests are frequently used in functional validation to verify host targets.

Key words: Molecular approaches, pathogens, virulence factors.

Introduction

Understanding virulence factors in plant pathogens involves identifying molecular components like effectors, toxins, enzymes, and adhesion proteins that allow pathogens to evade host defenses, colonize tissues, and cause disease symptoms; virulence is defined as the quantitative degree of host damage rather than just pathogenicity; these factors affect plant cellular processes like gene silencing, MAPK signaling, vesicle trafficking, and hormone pathways; for example, bacterial type III effectors like HopM1 from *Pseudomonas syringae* target ARF-GEF proteins like AtMIN7 to interfere with immunity-related trafficking (Speth *et al*., 2007). Virulence factors, which are frequently provided via type III/IV secretion systems in bacteria or by direct fungal hyphal invasion, enable pathogen adherence, penetration, nutrition acquisition, and suppression of basal defenses such as PAMP-triggered immunity (PTI). Avr factors function as both pathogenicity determinants and recognition targets in gene-for-gene interactions. They evolve quickly by mutations, deletions, or diversifying selection to avoid R proteins, as demonstrated in systems such as rice-*Magnaporthe oryzae* or flax-*Melampsora lini* (Hossain *et al*., 2023). Quantitative real-time PCR (qRT-PCR), which amplifies and quantifies potential virulence genes, such as effectors or toxin biosynthesis loci, from pathogen isolates during host interaction, is one of the molecular tools for identifying virulence factors in plant pathogens (Van Doorn *et al*., 2007). In model plants like *Arabidopsis* or *Nicotiana benthamiana*, gene knockout techniques, such as CRISPR-Cas9 editing and RNA interference (RNAi), disrupt particular virulence genes to evaluate their function in pathogenicity through decreased lesion formation or unsuccessful host colonization.

By amplifying virulence genes such as hrp, pth, and vir from bacterial pathogens or effector genes in fungi, PCR enables direct detection without the need for cultivation. Variants that measure and identify several virulence factors simultaneously in infected tissues include multiplex PCR, nested PCR, and real-time PCR (qPCR). These methods enable high-throughput screening for organisms with certain virulence profiles by using primers created from known pathogenicity genes (Haas *et al*., 1995).

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Bacterial Virulence Genes

Using particular primers like DXoo_hrp1F and DXoo_hrp1R, the hrp (hypersensitive response and pathogenicity) gene cluster in bacteria like *Xanthomonas oryzae* pv. *oryzae* is amplified, producing a 384 bp product for sensitive detection down to 2.6 x 10^2 CFU/ml in rice seeds and leaves. Similar to this, pathovar-specific primers are used to target pth genes in *Xanthomonas axonopodis* pv. *citri* and vir genes (such as virD2) in *Agrobacterium* spp. for quantitative real-time PCR, identifying pathogenic strains and measuring infection levels.

Fungal Effector Genes

Even at low pathogen loads (1-100 cells), fungal effector genes which increase virulence by inhibiting plant immunity can be identified without culturing by PCR on internal transcribed spacer (ITS) regions or particular effector sequences, frequently from direct tissue samples. In necrotrophic fungi, transcription factors such as PnPf2 control these effectors, and PCR verifies their expression during infection (Jones *et al*., 2019)

By methodically deleting genes in pathogens or hosts, CRISPR-Cas9 allows high-throughput genetic screens to identify those crucial for virulence by tracking changes in infection outcomes. Virulence factors are defined by these tests as genes whose disruption reduces pathogen growth, survival, or host damage. This method has identified bacterial and viral components essential to the development of disease (Zhu *et al*., 2024)

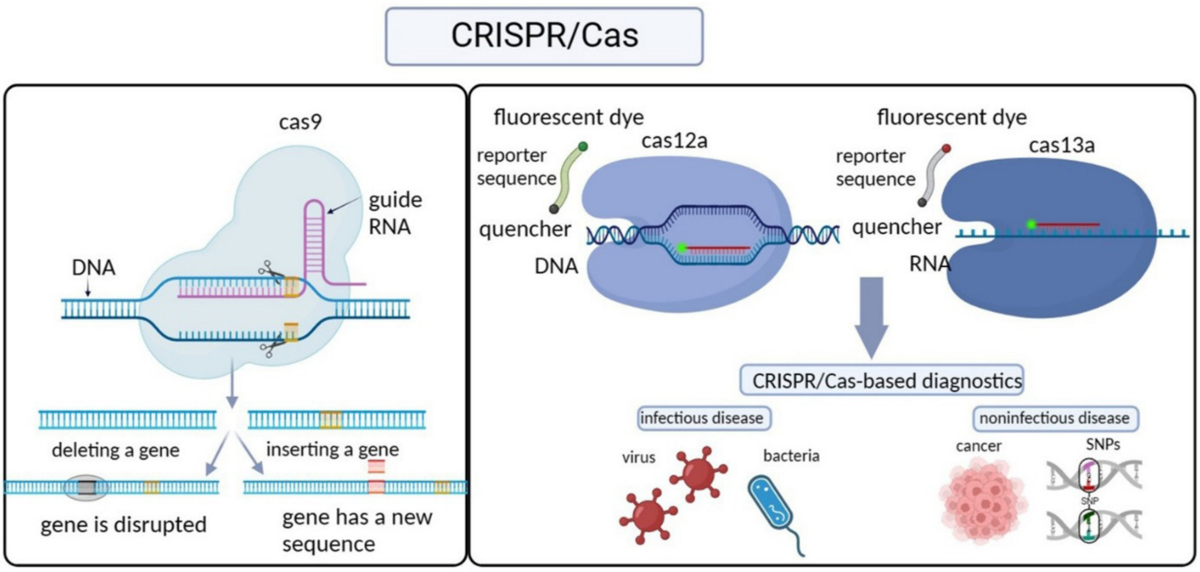

Figure 1: Illustration of CRISPR-Cas sensing mechanisms and their diagnostic application. (Source: Zeng *et al*., 2024)

Under the guidance of sgRNA, CRISPR-Cas9 generates double-strand breaks at particular genomic locations, resulting in insertions or deletions via non-homologous end joining. Editing virulence genes, such as those for effectors, poisons, or cell wall degraders, results in mutants with reduced infection in plant diseases, such as fungi or oomycetes. Phenotypic tests (such as lesion size on host plants) assess gene function, while sequencing confirms edits (Dort *et al*., 2020).

Hairpin RNA (hpRNA), which generates small interfering RNAs (siRNAs) that target pathogen mRNAs, is

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expressed in plants by RNAi through host-induced gene silencing (HIGS). During haustorial invasion, these siRNAs enter the pathogen and cleave virulence gene transcripts, such as PtMAPK1 or PtCYC1 in *Puccinia triticina*, lowering their levels by 40–65%. This confirms the roles of genes in host colonization by causing slowed fungal growth, fewer/smaller uredinia (lesions), and up to 79% reduced biomass accumulation in model systems (Panwar *et al*., 2018).

Conclusion

The advancement of disease management techniques in agriculture depends on the identification of virulence factors in plant diseases. Virulence factor identification has been transformed by cutting-edge methods such as metabolomics, genomics, and in planta expression analysis. Targeted breeding for resistant crops and innovative biocontrol agents is informed by an understanding of these networks. Finding strain-specific mechanisms through the integration of CRISPR-Cas9 and multi-omics will open the door to durable disease resistance. Using this information to combat emerging pathogen threats to promotes sustainable agriculture.

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Flaxseed: Nature's Nutrient Booster

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Abstract:

Flaxseed (*Linum usitatissimum*), also known as linseed, is one of the oldest cultivated crops and is widely valued for its nutritional and medicinal properties. It is rich in omega-3 fatty acids, especially alpha-linolenic acid (ALA), along with dietary fiber, high-quality protein, lignans, vitamins, and minerals, such as calcium, magnesium, phosphorus, potassium, and iron. Because of its unique composition, flaxseed is considered a low-saturated-fat food and an excellent plant-based source of omega-3 fatty acids.

Flaxseed offers numerous health benefits. Its soluble and insoluble fiber helps reduce blood glucose and cholesterol levels, improve digestion, and prevent constipation. The presence of lignans and other phytochemicals provides strong antioxidant activity, which may help reduce the risk of heart disease and certain cancers, including breast and prostate cancer. Flaxseed oil supplementation has also been reported to improve psychological health and reduce symptoms of depression. In addition, flaxseed may help reduce menopausal symptoms and support overall hormonal balance.

Flaxseed is widely incorporated into functional foods because of its rich nutrient composition and beneficial functional properties. In addition, flaxseed cake, the residual by-product of oil extraction, is rich in protein and dietary fiber, reinforcing its importance as a functional and nutraceutical ingredient.

Keywords: Flaxseed, ALA, Lignans, Neutraceutical

Introduction: Flaxseed (*Linum usitatissimum*), also known as linseed, is one of the oldest cultivated crops in the world, with a history going back thousands of years to ancient Egypt and China. Traditionally valued for both nutrition and medicinal use, flaxseed continues to gain attention as a functional food due to its rich nutrient composition. It contains 40% oil and 20% protein and it is an excellent source of dietary fiber, high-quality protein, healthy lipids, omega-3 and omega-6 fatty acids, lignans, phytochemicals, and several B vitamins. A daily intake of 25–50 g can significantly contribute to essential minerals such as manganese, potassium, phosphorus, iron, zinc, calcium, and copper.

Flaxseed is particularly known for its high content of alpha-linolenic acid (ALA), a plant-based omega-3 fatty acid which is known for its cardio protective effects. Flaxseed oil is a rich source of polyunsaturated fatty acids (70–73% PUFA), contains about 18% monounsaturated fatty acids (MUFA), and only 9–11% saturated fatty acids, making it low-saturated-fat and heart-friendly edible oil. In addition, flaxseed is one of the richest

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natural sources of lignans, plant compounds with strong antioxidant activity that help protect cells and support hormonal balance.

Flaxseed is commonly consumed in three forms: whole seeds, ground powder, and oil. The form of consumption affects nutrient stability and bioavailability. Beyond direct consumption, flaxseed is widely incorporated into functional food products due to its nutritional and technological properties. Flaxseed cake, a by-product of oil extraction, is also a valuable ingredient rich in protein and dietary fiber. Flaxseed cake can be effectively incorporated into bakery products, snack formulations, functional health mixes, and animal feed applications. Its utilization enhances the nutritional quality and functional properties of developed products while promoting sustainable processing practices through the efficient use of agro-industrial by-products and reduction of processing waste.

Component	Value (g/100g)
Moisture	4.53
Protein	20
Fat	41
Dietary fibre	25
Ash	3.47
Carbohydrates	29

Minerals	Value (mg/100g)
Calcium	228
Magnesium	427
Iron	6.10
Potassium	810
Zinc	4.4
Phosphorus	645

Nutritive value of flaxseed:

Nutritional Composition of flaxseed (g/100g) (Amala, B. 2016)

Health benefits of flaxseed:

- Flaxseed supports overall health due to its rich nutrient and bioactive profile, contributing to cardiovascular, digestive, and metabolic well-being.
- The soluble and insoluble fiber present in flaxseed helps lower blood glucose levels, reduce serum cholesterol, and promote healthy digestion.
- The phytochemicals of flaxseed such as phenolic acids, cinnamic acids, and flavonoids that act as antioxidants, protecting the body against oxidative stress, heart disease, and certain cancers.
- Lignans found in flaxseed may help reduce menopausal symptoms and support hormonal balance.
- Due to their ability to interact with estrogen receptors, flaxseed lignans exhibit potential anti-carcinogenic properties and may help lower the risk of hormone-related cancers such as breast, prostate, and endometrial cancer (Mueed et al., 2023).
- Flaxseed oil supplementation has been reported to positively influence brain-derived neurotrophic factor (BDNF) levels and improve psychological health, with studies showing a reduction in depressive symptoms among women (Poorbaferani et al., 2020).
- Flaxseed is naturally gluten-free and possesses anti-inflammatory properties, making it suitable for individuals with celiac disease, gluten sensitivity, or seafood allergies as a plant-based alternative

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source of omega-3 fatty acids.

Conclusion:

Flaxseed is a nutrient-rich functional food with multiple health benefits due to its high content of omega-3 fatty acids, dietary fiber, protein, and lignans. Regular consumption may support heart health, improve digestion, balance hormones, and reduce the risk of chronic diseases. Its versatility and nutritional value make it an important neutraceutical ingredient in the development of healthy and value-added food products.

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Enhancing Farmers' Income through Flower-based Intercropping in Dragon Fruit Orchards

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Dragon fruit cultivation has become an important livelihood option for farmers in the dry and semi-arid regions of Andhra Pradesh. The crop is well suited to water-scarce conditions and offers attractive market prices. Many farmers have adopted dragon fruit with the hope of securing stable income and reducing risk compared to traditional field crops.

However, during the early bearing stage of dragon fruit orchards, farmers often face a practical problem. While the crop starts yielding early, the income from dragon fruit alone is sometimes insufficient to meet recurring expenses such as irrigation, fertilizers, labour, plant protection, and maintenance of concrete poles. At the same time, the wide spacing followed in dragon fruit cultivation leaves a large portion of interspace unused. This unproductive land represents a missed opportunity for income generation.

To overcome this challenge, a simple and farmer-friendly innovation was demonstrated at the Horticultural Research Station, Anantapuramu—flower-based intercropping in dragon fruit orchards. The objective was to utilize the available interspace effectively and generate additional income without affecting the main crop.

Smart Use of Interspace through Flower Crops

Flower crops were selected as intercrops because of their short duration, shallow root system, and minimal competition with dragon fruit for water and nutrients. Among the flower crops evaluated, marigold and China aster proved to be highly compatible with the orchard system.

Farmers were initially cautious, fearing that intercropping might reduce dragon fruit yield. However, the results clearly demonstrated that dragon fruit yield remained stable at 5 tonnes per acre, even after introducing flower crops. This observation built confidence among farmers that intercropping can be safely adopted without any risk to the main crop.

Marigold Emerges as the Most Profitable Intercrop

Among the flower crops, marigold emerged as the most rewarding option. Marigold produced a yield of **4 tonnes per acre**, while China aster yielded **2 tonnes per acre**. Because of its higher yield, lower cultivation cost, and steady market demand, marigold provided superior economic returns.

Dragon fruit grown alone resulted in a net return of about ₹3.50 lakh per acre. When marigold was introduced as an intercrop, the net return increased to ₹4.25 lakh per acre, giving farmers an additional income of ₹75,000 per acre. Dragon fruit intercropped with China aster also performed well, with net returns of ₹4.20 lakh per acre, but marigold proved slightly better in overall profitability.

The benefit–cost ratio clearly showed the advantage of marigold intercropping. When dragon fruit was grown with marigold, the B:C ratio was 1:2.4, while dragon fruit grown alone recorded a B:C ratio of 1:2.3. In practical terms, this means that for every ₹1 invested, farmers earned about ₹2.40 by adopting marigold as an intercrop, compared to ₹2.30 when dragon fruit was grown alone. Though the difference may appear small, it translates into a substantial increase in net income per acre, especially when input costs are high. The additional income came without increasing risk or affecting dragon fruit yield, making marigold intercropping a more efficient and profitable option for farmers.More Than Just Extra Income

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The benefits of marigold intercropping were not limited to additional income alone. Farmers observed several positive changes within the orchard ecosystem. The bright marigold flowers attracted pollinators such as bees and butterflies, which improved pollination in dragon fruit. Better pollination resulted in improved fruit set, uniform fruit size, and enhanced fruit quality—key factors for fetching better prices in the market.

Intercropping also helped farmers make better use of available labour and irrigation. Since orchard operations were already being carried out for dragon fruit, managing marigold required only marginal additional effort. Regular flower harvests provided steady cash flow, enabling farmers to meet routine expenses without financial stress.

Another important advantage was risk reduction. Income from marigold acted as a safety net during periods of price fluctuation or delayed returns from dragon fruit. Farmers felt more confident knowing that their earnings were not dependent on a single crop.

A Farmer-Friendly and Replicable Model

One of the strongest advantages of the dragon fruit + marigold system is its simplicity. The practice does not require expensive inputs or specialized skills. It fits easily into existing orchard management practices and can be adopted by small and marginal farmers with limited resources.

By converting unused interspace into a productive component, farmers achieved better land-use efficiency and higher overall returns from the same area. The system demonstrated that an additional income of ₹70,000–₹80,000 per acre can be generated without increasing risk or affecting the main crop.

Conclusion

The success of marigold intercropping in dragon fruit orchards highlights how thoughtful use of available resources can significantly enhance farm income. This simple innovation transformed idle orchard space into a reliable source of additional earnings while improving orchard ecology and management efficiency.

Flower-based intercropping, particularly with marigold, has proven to be a practical, low-risk, and profitable approach for dryland horticulture. The model offers a clear pathway for farmers to strengthen income security, improve sustainability, and make dragon fruit cultivation more resilient in the face of rising costs and climatic uncertainty.

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Conveyors in Feed Mills: Streamlining Efficiency and Material Handling

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Abstract

In the modern feed milling industry, the efficiency of material handling is the backbone of production. Traditional manual material handling is not only labor-intensive, accounting for nearly 45% of total labor costs, but also prone to inefficiencies such as poor flow, dust accumulation, and material spillage, which can lead to production losses of up to 40%. This article examines the evolution of conveyor systems—from simple mechanical chain-driven devices to smart, AI-integrated automated systems—and their critical role in optimizing feed mill operations. By leveraging advanced simulation technologies like the Discrete Element Method (DEM) and integrating the Internet of Things (IoT), feed mills can achieve significant improvements in batching accuracy and overall throughput.

Keywords: Conveyor systems, Feed milling, Material handling, Automation, Discrete Element Method (DEM), IoT in agriculture.

Introduction : The primary objective of any feed processing plant is to convert raw materials into uniform, high-quality feed through precise mixing and batching. However, this objective is often hindered by the physical complexities of handling bulk solids. Issues such as material segregation, dust generation, and mechanical downtime represent significant barriers to profitability. As feed processing plants aim for higher throughput, the reliance on automated conveyor systems has become a strategic necessity. By transitioning from manual handling to continuous, automated material flow, mills can improve overall operational efficiency by approximately 35%. This article explores the mechanical evolution of conveyors and how modern data-driven technologies are turning these systems into "intelligent" components of the production line.

The Economic and Operational Imperative : The decision to invest in conveyor technology is driven by two key factors: labor costs and production efficiency. Manual labor is inherently slow and inconsistent, often resulting in bottlenecks during the intake or batching stages. Furthermore, the handling of bulk solids is notoriously difficult; improper flow or excessive spillage is not just an environmental hazard but a direct drain on resources.

Mechanical systems, ranging from endless chains to buckets and rollers, provide a continuous flow that ensures the consistent delivery of ingredients to the mixer. This consistency is paramount. In modern feed formulations, even a minor deviation in the proportion of micronutrients can impact the final feed quality. Therefore, a conveyor system that ensures precise delivery is as important as the mixer itself.

Categorization and Mechanics of Conveyor Systems : Every conveyor system is custom-built to match the specific requirements of the plant. Broadly, these systems are categorized based on their conveying direction and mechanical action:

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- **Horizontal Conveyors:** These are the workhorses of the feed mill, typically using belts, screws (augers), or drag chains to transport materials between processing stages.
- **Vertical Conveyors:** Essential for facilities with limited floor space, these systems—such as bucket elevators—lift materials to storage bins or mixing towers.
- **Mechanical Drives:** Systems have evolved from simple manual or gear-driven mechanisms to advanced chain-driven or belt-driven configurations designed to minimize dust and maximize hygiene.

The capacity of a conveyor system is the primary design metric. It is influenced by variables such as belt speed, the angle of inclination, the density of the material being moved, and the distance between processing points. Understanding these variables allows engineers to optimize the horsepower required for the system, ensuring that the plant operates at peak energy efficiency.

Simulation and Engineering: The Discrete Element Method (DEM)

A significant advancement in the design of conveyor systems is the application of the Discrete Element Method (DEM). Traditionally, conveyor design was a trial-and-error process. Today, computerized simulation technology allows engineers to model the behavior of bulk solids before a single piece of equipment is installed.

DEM simulations can predict how granular materials will flow, where clogging is likely to occur, and how dust can be managed through improved casing design. By simulating the interaction between particles and conveyor components, engineers can maximize feed efficiency and reduce the wear and tear caused by abrasive feed ingredients.

The Rise of the Intelligent Mill: IoT and AI Integration

The most transformative change in recent years is the transition from "dumb" hardware to smart, IoT-enabled infrastructure. Modern conveyors are now equipped with sensors that track the health of components—such as roller bearings, chain tension, and motor heat—in real time.

- **Predictive Maintenance:** Through AI-based monitoring, systems can detect vibrations or heat signatures that indicate an impending failure, allowing for repairs to be scheduled *before* a breakdown occurs. This has been shown to reduce conveyor downtime by up to 70%.
- **Smart Batching:** Integrated AI software can make automated decisions on flow rates based on the needs of the batching system, ensuring that the mixer never starves for material.
- **Performance Tracking:** Companies like Van Aarsen (with their MES Toolbox) have demonstrated that integrating smart monitoring can improve overall plant performance by 10–30%.

Conclusion

Conveyors have progressed far beyond their initial role as simple "movers" of material. They are now highly sophisticated, custom-engineered systems that act as the circulatory system of the feed mill. Through the integration of DEM simulation, IoT, and AI, feed mills are moving toward a future of fully automated, predictive, and highly efficient production. For the modern mill owner, investing in intelligent conveyor solutions is not

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just about moving grain; it is about creating a data-driven environment that ensures consistency, reduces labor costs, and maximizes the profitability of every ton of feed produced.

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From Waste to Wealth: Empowering a Marginalized Woman through Mushroom Enterprise – A Success Story from KVK Guntur

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Abstract

Mrs. Ruthu from Ippatam village in Guntur district, Andhra Pradesh, belonged to a marginalized community and earlier worked as a waste picker, earning a low and irregular income that kept her in poverty. Her life changed after receiving training under the STRY programme from KVK Guntur, supported by ATMA and DBRC. Through a 7-day hands-on training in mushroom cultivation and continuous guidance from KVK experts, she gained both technical and entrepreneurial skills. Starting with a few mushroom beds using locally available waste and low-cost methods, she gradually expanded to 20 beds and now produces about 8 kg of milky mushrooms daily, earning around ₹35,000 per month. This has provided her with financial stability, improved living standards, and increased confidence. Her enterprise is low-cost, eco-friendly, and scalable, and her transformation from a waste picker to a successful entrepreneur demonstrates the powerful role of skill development and institutional support in empowering rural women and reducing poverty.

Background

Mrs. Ruthu, wife of Harikrishna, is from Ippatam village in Mangalagiri Mandal of Guntur district, Andhra Pradesh. She comes from a marginalized community and faced many hardships in her life. With limited education, few resources, and no stable job opportunities, it was very difficult for her to support her family.

For many years, Ruthu worked as a waste picker. The work was physically tiring and socially looked down upon. Even after working hard every day, her income was very low and irregular, which was not enough to meet her family's basic needs. Due to lack of skills and stable livelihood options, she remained stuck in poverty with very little hope for improvement.

Problem Statement

Ruthu's situation reflects a broader issue faced by many rural women:

- Lack of skill-based livelihood opportunities
- Dependence on low-paying informal labour
- Absence of access to institutional support and market linkages
- Limited awareness of sustainable and profitable agri-enterprises

There was an urgent need for an intervention that could provide skill development, income generation, and long-term livelihood security.

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Intervention by KVK Guntur

The turning point in Ruthu's life came through her participation in the Skill Training for Rural Youth (STRY) program implemented by KVK Guntur.This program was supported through convergence with ATMA (Agricultural Technology Management Agency) and DBRC – District Business Resource Centre. Recognizing mushroom cultivation as a low-cost, high-return enterprise suitable for landless and marginal women, KVK Guntur selected Ruthu for caapacity building.

She underwent a **7-day intensive hands-on training** covering:

- ✓ Scientific mushroom production techniques
- ✓ Phase I & II composting
- ✓ Spawning, casing, pinning, cropping, and harvesting
- ✓ Low-cost production methods
- ✓ Business planning and marketing strategies

Capacity Building and Skill Enhancement

The training focused not only on technical skills but also on entrepreneurial development. Ruthu gained confidence in:

- ✓ Utilizing agricultural and kitchen waste for compost preparation
- ✓ Managing climate conditions using low-cost methods
- ✓ Understanding market demand and pricing strategies

This holistic approach ensured that she was not just trained as a producer but empowered as an entrepreneur.

Handholding and Technical Support

KVK scientists provided continuous mentoring and technical backstopping:

- ✓ Regular field visits and on-site guidance
- ✓ Troubleshooting support during production cycles
- ✓ Advisory services on disease management and yield improvement

This sustained handholding played a critical role in building her confidence and ensuring successful enterprise establishment.

Institutional and Financial Convergence

The initiative benefited from institutional convergence, which enabled:

- ✓ Access to training infrastructure and expert guidance

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- ✓ Linkages with local agencies and support systems
- ✓ Reduced financial burden through low-cost technologies

Though the enterprise required minimal investment, support from local networks and institutions ensured smoother implementation.

Enterprise Establishment: From Humble Beginnings

With newly acquired skills and support, Ruthu started mushroom cultivation in her backyard with a few beds. She adopted:

- Locally available agricultural and kitchen waste for composting
- Thatched roofing and wet gunny bags for temperature and humidity control

Her approach emphasized **low-cost, eco-friendly, and resource-efficient production**.

Through consistent effort and perseverance, she gradually scaled up her operations.

Economic Gains and Returns

Today, Ruthu manages around 20 mushroom beds and produces nearly 8 kg of milky mushrooms every day. From this enterprise, she earns a stable monthly income of about ₹35,000. This is a significant improvement compared to her earlier earnings as a waste picker. The mushroom unit now provides her with regular cash flow, financial stability, and has greatly improved her household living standards.

Viability and Sustainability

The mushroom enterprise has proven to be:

- **Economically viable:** Low investment with high returns
- **Technically feasible:** Simple, skill-based technology
- **Environmentally sustainable:** Utilization of agricultural waste promotes circular economy

The model ensures long-term sustainability due to its low dependency on external inputs.

Scalability and Replicability

The success of Ruthu's enterprise demonstrates high potential for scaling:

- Suitable for landless and small farmers
- Requires minimal space and investment
- Short production cycles ensure quick returns

The model can be replicated through:

- Self-Help Groups (SHGs)

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- Farmer Producer Organizations (FPOs)
- Cluster-based approaches

Impact and Outcomes

The intervention brought a significant socio-economic transformation in Ruthu's life. Her monthly income increased to around ₹35,000, providing her with a stable and diversified livelihood. She gained confidence and social recognition, moving from a marginalized labourer to a successful entrepreneur. Her dependence on informal and exploitative work has reduced, and her enterprise has also created local employment opportunities. By using agricultural and kitchen waste effectively, she promotes environmentally sustainable practices. Today, Ruthu stands as a role model in her community, inspiring other women to take up mushroom cultivation for a better livelihood.

SDG Linkages

This initiative directly contributes to the following Sustainable Development Goals:

- **SDG 1: No Poverty** – Ensuring sustainable income and livelihood security
- **SDG 5: Gender Equality** – Empowering women through entrepreneurship
- **SDG 8: Decent Work and Economic Growth** – Promoting productive employment
- **SDG 12: Responsible Consumption and Production** – Encouraging waste-to-wealth practices.

Key Indicators of Success

- Income increase: From negligible to ₹35,000/month
- Production capacity: 20 beds, 8 kg/day
- Employment generation: Self and potential for others
- Adoption potential: High among rural women

Conclusion

Ruthu's journey from a waste picker to a successful mushroom entrepreneur exemplifies the transformative power of skill development, institutional support, and scientific intervention. The role of KVK Guntur in providing capacity building, continuous mentorship, and enabling ecosystem support has been instrumental in this transformation.

This success story highlights a replicable and sustainable model for empowering marginalized women, converting waste into wealth, and achieving inclusive rural development. It stands as a strong example of how targeted interventions can break the cycle of poverty and create pathways for dignity, self-reliance, and economic empowerment.

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Empowering Livelihoods through Mushroom Enterprises