AGRI UPTODATE

VOLUME 1 | ISSUE 10 | OCTOBER 2026



AGRICULTURE: INNOVATION ROOTED IN NATURE

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It gives me immense pleasure to present the inaugural issue of Agri UptoDate (January 2026)—a humble yet determined step toward bridging the gap between agricultural research, innovation, and real-world practice. This first volume reflects our core vision: to make credible, research-backed agricultural knowledge accessible to students, researchers, entrepreneurs, and farming communities alike.



Editor's Note

The current issue brings together a diverse range of themes that are highly relevant in today's rapidly transforming agri-ecosystem. Articles such as "Climate Change Impacts on Vegetable Crops" highlight the pressing challenges faced by production systems, while "Impact of Digitalization on Agriculture and Agripreneurship: A Research-Oriented Perspective" showcases how technology, innovation, and entrepreneurship are reshaping the future of agriculture. Practical and emerging areas such as Mushroom Farming, Lawn Establishment, and Maintenance provide practical value for readers seeking enterprise and livelihood opportunities. The inclusion of Service-Based Startups further expands the discussion beyond conventional farming, reflecting the growing importance of agri-services and knowledge-driven enterprises.

This issue is the result of sincere contributions from researchers, academicians, and young professionals, and I extend my heartfelt gratitude to all authors for sharing their insights and expertise. I also thank our readers for placing their trust in this new initiative.

We hope Agri UptoDate will evolve into a reliable platform for knowledge exchange, critical thinking, and innovation in agriculture. Your feedback, suggestions, and continued support will be crucial in shaping future issues.
Happy reading and learning.

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Editor-in-Chief

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WHY A CUT MATTERS: ROLE OF CUTTING IN VEGETABLES

Darshan B. Kasundra

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HIGHLIGHTS OF THE ARTICLE

When vegetables are cut, they activate wound-induced nutrition — a biological defense mechanism that can increase protective compounds rather than destroy them. In broccoli, uncut florets contain negligible sulforaphane, but after cutting and resting 30-40 minutes, levels increase 2-3 times due to enzyme activation. Similarly, crushing garlic for 10-15 minutes before cooking produces allicin, explaining traditional culinary practices. Coloured vegetables like purple cabbage boost antioxidants (anthocyanins) after cutting. However, potato and brinjal suffer differently: cutting triggers polyphenol oxidase, causing browning and nutrient loss, so they should be cooked immediately. The article also busts the myth that cutting instantly destroys vitamin C; total content remains relatively stable within 24 hours. The key takeaway: cutting's impact depends on vegetable type. Some benefit from resting, others require quick cooking to preserve nutrition and quality.

Keywords: Allicin, antioxidants, enzymatic browning, polyphenol oxidase, sulforaphane, vitamin C leaching, wound induced nutrition

Most of us think that a vegetable is at its healthiest at the moment when it is picked, and that every cut, chop or crush after that can only reduce its goodness. Science tells a more interesting story. When a vegetable is cut, crushed or even bitten into, it is not simply damaged; its cells respond the way a living organism responds to an injury.

This response, called "wound induced nutrition," can actually increase the amount of certain protective compounds in the vegetable. A piece of broccoli or a crushed clove of garlic can become more beneficial after cutting than it was before, simply because of how it is cut and how long it is left to rest before cooking. But cutting is not all good news either. The very same biochemical machinery that boosts certain nutrients is also responsible for some well-known problems like browning, softening and nutrient loss in vegetables, such as potato and brinjal (eggplant).

A Vegetable Is Still "Alive" After Harvesting

A freshly harvested vegetable is not a dead, fixed block of nutrients. Its cells are still active, separated into tiny compartments, each holding different chemicals and enzymes. Some of these chemicals are harmless on their own, but turn into powerful, health-protective compounds the moment the cell is damaged and the contents of different compartments mix together. This is the plant's natural defence mechanism. Over millions of years, plants developed ways to react to being eaten or injured by insects, hail, or animals. A kitchen knife triggers the very same ancient defence system.

What Really Happens When You Cut a Vegetable

In simple terms: cutting breaks the walls that normally keep certain chemicals and enzymes apart inside the plant cell. Once mixed, these chemicals react with each other within seconds to minutes, producing new compounds. Many of these new compounds are antioxidants or other protective substances that benefit human health when eaten.

The vegetable also sends out an internal "alarm signal" from the wound site to the rest of the tissue, which is why the effect is not only limited to the exact spot of the cut, but spreads through the vegetable over the following minutes and hours.

Broccoli and Sulforaphane: The Best-Known Example

Broccoli, cabbage, and cauliflower (the cruciferous vegetables) contain a compound called glucoraphanin and a separate enzyme called myrosinase, normally kept apart inside the cell.

When the vegetable is cut or chewed, the two come into contact and react to form sulforaphane, a compound well known for its antioxidant and anti-inflammatory effects, and widely studied for its protective role in

cancer prevention. Sulforaphane does not exist in any meaningful amount inside an uncut broccoli floret. It is created only after cutting or chewing.

Kitchen Tip: Timing Matters

If freshly cut broccoli is cooked immediately (for example, dropped straight into boiling water), the enzyme myrosinase is destroyed by heat before it can finish making sulforaphane, and the yield is much lower. If the cut broccoli is instead left to rest at room temperature for about 30–40 minutes before cooking, the enzyme has time to complete the reaction, and the final sulforaphane content can be two to three times higher — even after cooking. Finer chopping also helps, since smaller pieces expose more enzyme to more substrate.

- Chop broccoli, cauliflower, or cabbage finely.
- Let it rest for 30–40 minutes before cooking.
- Add a little raw, finely chopped crucifer (such as raw radish or mustard greens) to a cooked dish — it supplies active enzyme that boosts the final benefit.

Garlic and Onion: The Allicin Effect

Garlic works on a very similar principle. An intact garlic clove contains a sulphur compound called alliin and an enzyme called alliinase, kept in separate parts of the cell. Crushing or mincing the clove breaks this separation, and the two react within seconds to form allicin — the compound responsible for garlic's sharp smell and much of its antimicrobial and heart-protective reputation.

The traditional cooking advice of crushing garlic and letting it sit for 10–15 minutes before adding it to a hot pan is, therefore, good biochemistry, not just a culinary habit. It gives the allicin-forming reaction time to complete before heat destroys the enzyme.

Indian researchers at the ICAR-National Institute of Plant Biotechnology, New Delhi, have reviewed how garlic's processing method directly affects its allicin content and its associated biochemical and medicinal value, reinforcing that how garlic is cut and handled in the kitchen genuinely changes its nutritional output.

Colourful Vegetables: Cabbage, Lettuce, and Carrots

Cutting also triggers the production of polyphenols and flavonoids — plant compounds known for their antioxidant properties — in many other vegetables:

- Lettuce: Cutting and minor wounding increases total phenolic content noticeably within 24 hours.
- Purple cabbage: Cutting boosts the production of anthocyanins, the same pigments responsible for the vegetable's deep colour. A freshly cut red cabbage that looks more vividly coloured a day later is not spoiling — it is producing more antioxidants.
- Carrots: The area around a fresh cut becomes richer in certain protective compounds, although this is also linked to the browning that occurs at cut surfaces.

Interestingly, exposing cut vegetables to ordinary light (not direct sun, just regular indoor light) during short-term storage can further increase this antioxidant boost, without affecting taste or causing spoilage at normal storage times.

What About Vitamin C?

A common belief is that cutting a vegetable instantly destroys its vitamin C. This is only partly true. Some vitamin C is indeed used up right at the cut surface as part of the vegetable's own defence reaction. However, research shows that the vegetable often compensates by producing more vitamin C in the surrounding tissue. In several studies on carrot, potato, and spinach, the total vitamin C content of the vegetable did not drop in the first 24 hours after cutting.

This means short-term cutting and preparation (within normal kitchen timeframes) is not the vitamin C risk it is often made out to be. The bigger losses happen with prolonged storage, high heat or excessive soaking in water.

The Other Side: When Cutting Causes Real Losses

So far this has been the good news. But cutting a vegetable is not a one-way street to better nutrition. The very same wound response that creates beneficial compounds in broccoli or garlic can just as easily cause real nutrient loss, poor texture, and food-safety problems in other vegetables. A balanced understanding needs both sides.

Enzymatic Browning: Potato, Brinjal and Other Veggies

Potato and brinjal (eggplant) are classic examples of vegetables where cutting is mostly bad news. These vegetables are rich in an enzyme called polyphenol oxidase (PPO). The moment the cell is cut, PPO is released and immediately reacts with the vegetable's own phenolic compounds (the same antioxidant-related compounds that are beneficial elsewhere), converting them into brown-coloured pigments. This is why a cut potato or brinjal turns grey-brown within minutes of exposure to air.

This browning is not just unattractive; it is a genuine nutritional loss. The phenolic antioxidants that are destroyed in this reaction are gone, not transformed into anything beneficial. Studies estimate that browning of this kind can be responsible for roughly half of all post-harvest quality and nutrient losses in fruits and vegetables worldwide. Research on pearl brinjal (a variety of eggplant) has specifically studied how quickly PPO destroys its phenolic content after cutting, and has tested natural inhibitors (such as citric acid, lemon juice, and chilled water) to slow this damage down.

So unlike broccoli or garlic, where resting the cut vegetable before cooking helps, resting a cut potato or brinjal in open air mainly causes loss. These vegetables should be cooked soon after cutting, or kept submerged in water or treated with an acidic rinse (lemon juice, vinegar or salt water) to slow the browning enzyme down.

Leaching of Water-Soluble Vitamins

Vitamin C and B-group vitamins are water-soluble, meaning they can dissolve out of cut vegetable surfaces into water. Common Indian kitchen habits, such as chopping vegetables and then soaking or washing them in water for a long time before cooking, or leaving cut vegetables in water to keep them looking fresh, cause these vitamins to leach out and literally go down the drain. The more surface area is exposed (finer the cut) and the longer the soaking, the greater the loss.

Texture, Flavour, and Spoilage Problems

Wilting and sogginess: Cutting increases water loss from the exposed surface, which is why cut leafy greens and salad vegetables wilt much faster than whole ones.

Off-flavours: In some vegetables, the same wound-triggered enzyme activity that produces beneficial compounds elsewhere can also generate grassy, bitter or rancid-tasting compounds, especially if the cut vegetable is left exposed for too long.

Faster spoilage: A cut surface is an easy entry point for bacteria and fungi. Cut vegetables left at warm room temperature, — a particular concern in the Indian climate — spoil and become unsafe to eat far sooner than whole vegetables. This is an important food-safety reason to avoid pre-cutting vegetables many hours in advance.

The Balanced Picture

The honest summary is this: wound induced nutrition is not automatically good for every vegetable. For cruciferous vegetables (broccoli, cauliflower, cabbage) and for garlic and onion, a short rest after cutting genuinely helps. For PPO-rich vegetables like potato and brinjal, the same idea of "resting before cooking" works against you, cutting and exposure to air mainly destroys nutrients and spoils appearance. Knowing which category a vegetable falls into is the real, practical takeaway of this science.

Practical Kitchen Guidance

- Broccoli, cauliflower, cabbage: chop finely and rest for 30–40 minutes before cooking.
- Garlic and onion: crush or mince and let it sit for 10–15 minutes before adding to a hot pan.
- Leafy greens: tearing by hand instead of cutting with a metal knife can favour antioxidant build-up over browning.
- Root vegetables (carrot, radish, beetroot): light peeling, rather than deep peeling, preserves the nutrient-rich layer just under the skin.
- Potato and brinjal: cut close to cooking time, and keep cut pieces submerged in plain or lightly acidulated (lemon juice or vinegar) water to slow browning and nutrient loss.
- Avoid soaking any cut vegetable in large amounts of water for long periods, since this washes away water-soluble vitamins.

Conclusion

Cutting a vegetable is not simply good or simply bad for its nutrition; it is a genuine biochemical event that can go either way, depending on the vegetable. For broccoli, cabbage, garlic, onion, and many colourful vegetables, cutting and a short rest before cooking can meaningfully boost beneficial compounds. For potato, brinjal, and similar vegetables, cutting mainly triggers browning, nutrient loss, and faster spoilage, and is best managed by minimising air exposure and cooking soon after cutting. Knowing which side applies to a given vegetable and handling it accordingly is the most practical, balanced takeaway from this science.

Volume. 1, Issue 10, October 2026

CAN PLANTS HEAR US?

THE HIDDEN LANGUAGE OF THE GREEN WORLD

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A World We Cannot Hear

Step into a garden early in the morning, before the day is filled with the noise of human activity. Leaves sway gently in the breeze, droplets of dew glisten on petals, roots quietly explore the soil, and bees move from flower to flower. To our ears, the garden seems completely silent. Yet beneath this apparent silence, a remarkable world of signals, responses and interactions is constantly unfolding.

Plants may not have ears, a brain, or a nervous system like animals, but they are remarkably sensitive to their surroundings. They can perceive light, temperature, gravity, touch, water availability, chemicals and even mechanical vibrations. A root can alter its direction when it encounters an obstacle, while a climbing plant responds to touch as it searches for support. When attacked by herbivores, some plants release airborne chemical compounds that can alert nearby plants and activate their own defence mechanisms. Even flowers can detect and respond to vibrations associated with visiting pollinators.

Plants Are Sensitive to Their Surroundings

Though plants remain rooted in one place, they constantly sense and respond to their surroundings. This ability helps them survive, grow and reproduce.

- **Light:** Photoreceptors help plants detect light intensity and duration, influencing photosynthesis, growth and flowering.
- **Temperature:** Plants sense heat and cold and adjust processes such as germination, flowering and metabolism.
- **Gravity:** Through gravitropism, roots grow downward while shoots generally grow upward.
- **Touch:** Plants respond to physical contact. Climbers, for example, use touch to locate and wrap around supports.
- **Water:** Roots sense moisture and can grow towards areas with greater water availability, a response called hydrotropism.
- **Chemicals:** Plants detect nutrients, hormones and chemical signals. When attacked by insects, they may release volatile organic compounds (VOCs) that trigger defence responses.
- **Mechanical vibrations:** Plants can perceive vibrations caused by wind, rain and insects, and some vibrations may influence their growth and defence responses.

Can Plants Really "Hear"?

- When scientists ask whether plants can "hear," they do not mean that plants have ears or hear voices as humans do. Instead, they are exploring whether plants can detect and respond to sound-generated mechanical vibrations.
- Sound travels as vibrations through air or other materials. When these vibrations interact with plant tissues, they may trigger changes in cellular activity and physiological processes. Research has reported that certain sound frequencies or vibrations can influence root growth, seed germination, gene expression and other aspects of plant development.
- For example, studies have shown that roots can respond to specific vibrations, while exposure to certain acoustic frequencies has been associated with changes in seed germination and plant growth. However, the effects depend on factors such as frequency, intensity, duration and plant species.
- It is important to make one distinction clear: detecting vibrations is not the same as hearing like an animal. Plants do not possess ears or an auditory nervous system. Their response is better understood as a form of mechanosensing — the ability to perceive mechanical changes in their environment.
- So, can plants hear us? Not in the way we hear each other. But they may be capable of sensing some of the vibrations that surround them, revealing yet another fascinating way in which plants interact with their environment.

Flowers Can "Listen" to Their Pollinators

- Flowers may look silent, but they can respond to the vibrations produced by visiting insects. Bees, especially bumblebees, generate vibrations while feeding, which can help release pollen from flowers such as tomato and eggplant — a process called buzz pollination.
- Research also suggests that some flowers can respond to pollinator-related vibrations, potentially influencing nectar production and other floral responses. This may help plants make their reproductive resources more efficient.
- Of course, flowers do not "hear" like humans. They detect mechanical vibrations through their tissues. Over evolution, this sensitivity may have helped plants interact more effectively with their pollinators.

Plants Talk Without Words

- Plants communicate without voices, using chemical signals that travel through the air and soil. When attacked by insects or other herbivores, plants can release volatile organic compounds (VOCs) that may alert nearby plants and activate their own defence mechanisms.
- Communication also occurs underground. Roots release root exudates — a mixture of sugars, organic acids and other compounds that influence neighbouring plants and soil microorganisms. These chemicals help shape interactions between plants, beneficial microbes and fungi, influencing nutrient availability and plant health.
- In this hidden chemical world, plants are constantly sending, receiving and responding to signals — not through words, but through chemistry.

The "Wood Wide Web"

- Beneath the soil lies a hidden network formed by mycorrhizal fungi, which connect with plant roots and extend far into the surrounding soil. These fungal threads can help plants obtain water and nutrients, particularly phosphorus, while receiving carbohydrates from their plant partners.
- Through these interconnected networks, plants may also influence one another by exchanging chemical signals and resources. Such underground connections can affect how neighbouring plants respond to stress, competition and environmental changes.
- Often called the "Wood Wide Web," this underground network reminds us that a forest is not simply a collection of individual trees — it is an intricate community connected beneath our feet.

Plants Can "Feel" Touch

- Plants may not have nerves, but they can sense and respond to physical contact. This fascinating phenomenon is known as thigmomorphogenesis — changes in plant growth and form caused by mechanical stimulation.
- Climbing plants, for example, can detect contact with nearby structures and alter their growth to find support. Roots can sense obstacles in the soil and change their direction, while repeated touching, wind or mechanical movement can cause plants to develop shorter, stronger stems and altered growth patterns.
- These responses help plants adapt to their surroundings and survive challenging conditions.

Do Plants Have Intelligence?

- If plants can sense their surroundings, communicate, remember previous conditions and adjust their growth, can we call them intelligent?
- Plants constantly receive environmental information and respond through complex chemical, electrical and hormonal signals. Some can show forms of environmental memory, such as responding differently to stress based on previous exposure. These adaptive responses allow plants to adjust to drought, touch, temperature and competition.
- However, plants have no brain or conventional nervous system like animals. This has led scientists to debate whether terms such as "plant intelligence" and "plant cognition" are appropriate.
- Perhaps plant intelligence does not mean thinking as humans do. Instead, it may refer to their remarkable ability to sense, process information and adapt without a brain.

What About Music and Talking to Plants?

- Many people believe that talking to plants or playing music can make them grow better. While some experiments have reported changes in plant growth under certain sound or vibration conditions, the scientific evidence is still limited and inconsistent.
- Plants can detect mechanical vibrations, so sound waves may influence physiological processes under particular conditions. However, this does not mean that plants understand human speech or that classical music automatically makes them healthier.
- The important distinction is between scientific evidence and personal observation. A plant growing

well after being exposed to music does not necessarily prove that music caused the improvement. Factors such as light, temperature, water, nutrition and humidity can have a much greater influence.

From "Listening to Plants" to Plant-Based Technology

- Understanding how plants sense and signal their environment could transform modern horticulture. Scientists are developing sensors that can detect subtle changes in plants before visible symptoms appear, helping identify water stress, nutrient deficiency and disease at an early stage.
- Combined with AI, sensors and smart greenhouse systems, plant signals could guide precision irrigation, fertilization and climate control. Electrical and chemical signals produced by stressed plants may eventually allow growers to monitor plant health almost in real time.
- The future may therefore be less about simply looking at plants and more about listening to what they are telling us.

Why Understanding Plant Communication Matters

- Understanding how plants sense and respond to their environment is more than a scientific curiosity — it could become an important tool for sustainable horticulture and agriculture. As climate change increases heat and water stress, understanding plant signals may help us identify drought stress earlier and develop more climate resilient crops.
- Plant communication can also contribute to precision irrigation and reduced pesticide use by allowing growers to detect stress or disease before serious damage occurs. Understanding plant pollinator interactions may help protect pollination systems, while smarter green spaces and urban horticulture can improve the resilience of cities.
- The deeper we understand the hidden language of plants, the better we may become at working with plants rather than simply working on plants.

Conclusion: The Garden Is Not Silent

A garden may appear quiet, but beneath its silence lies a world of vibrations, chemical signals, electrical responses and hidden connections. Plants sense their surroundings, respond to touch, interact with microbes, communicate through chemical cues and respond to the organisms that depend on them. They may not speak in words or think as humans do, but their ability to sense, respond and adapt reveals a remarkably complex living world. Perhaps the real question is not whether plants can communicate, but whether we are finally becoming intelligent enough to listen.

Volume. 1, Issue 10, October 2026

INTEGRATED CROP MANAGEMENT FOR SUSTAINABLE AGRICULTURAL PRODUCTION IN RAJASTHAN

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ABSTRACT

Agricultural production in Rajasthan is challenged by variable rainfall, limited water availability, soil constraints and rising input costs. Integrated Crop Management (ICM) addresses these challenges by combining suitable crop and cropping-system selection, soil-test-based nutrient management, moisture conservation, efficient irrigation, integrated weed management and need-based pest and disease control. These practices are particularly relevant to rainfed and semi-arid areas, where crop performance depends on rainfall distribution and the efficient use of soil moisture and nutrients. Evidence from farmer-field demonstrations in south-eastern Rajasthan indicates that integrated management in mustard can improve productivity and economic returns compared with prevailing farmer practices. However, outcomes depend on crop requirements, local agro-climatic conditions, available resources and farm economics. This article outlines the major components of ICM and their potential contribution to productive, resource-efficient and sustainable agriculture in Rajasthan.

Keywords: Integrated Crop Management, sustainable agriculture, resource-use efficiency, soil health, water management, integrated pest management, Rajasthan.

Introduction

Agriculture in Rajasthan spans arid and semi-arid areas as well as relatively wetter parts of the south and south-east. Variable rainfall, long dry spells, limited irrigation, low soil fertility in many locations and salinity or alkalinity in affected areas can constrain crop production. These conditions make the efficient management of soil, water, nutrients and other farm inputs essential. Crop productivity therefore depends not only on the choice of crop but also on how well field operations are coordinated through the growing season.

Integrated Crop Management (ICM) is an approach that combines agronomic practices to improve crop performance and use available resources efficiently. Its components include selecting suitable crops and varieties, choosing appropriate cropping systems, applying nutrients according to soil-test results and crop needs, conserving soil moisture, managing weeds and monitoring pests and diseases. These practices should be adapted to crop growth stages, field conditions and weather rather than applied as isolated recommendations.

Field-level evidence from south-eastern Rajasthan has reported higher mustard seed yield, net returns and benefit–cost ratios under integrated crop management than under prevailing farmer practices. Such findings demonstrate the potential of ICM under the conditions evaluated, although results can vary by crop, location, season and management package. Agricultural universities, Krishi Vigyan Kendras (KVKs) and extension agencies can help farmers select locally suitable practices. ICM is therefore a practical framework for improving farm productivity while conserving resources.

1. Selection of Suitable Crops and Cropping Systems

Crop selection should reflect rainfall distribution, soil characteristics, moisture availability, irrigation facilities and the length of the growing season. Pearl millet (Pennisetum glaucum), clusterbean (Cyamopsis tetragonoloba) and moth bean (Vigna aconitifolia) are important options in many arid and semi-arid areas because they are suited to dryland conditions. Depending on the agro-climatic zone and water

availability, farmers may also grow maize, chickpea, mustard and other locally recommended pulses.

Crop rotation and intercropping can diversify farm output and improve the use of available resources. Pearl millet intercropped with clusterbean or moth bean is one possible option where locally recommended. Cereal-legume combinations can spread production risk and may help protect soil, depending on crop arrangement and field conditions. Legumes can contribute nitrogen through biological fixation, but the benefit depends on effective nodulation, crop growth, residue management and soil conditions. Farmers should select crop combinations and row arrangements based on local recommendations, rainfall patterns, available labour and market needs.

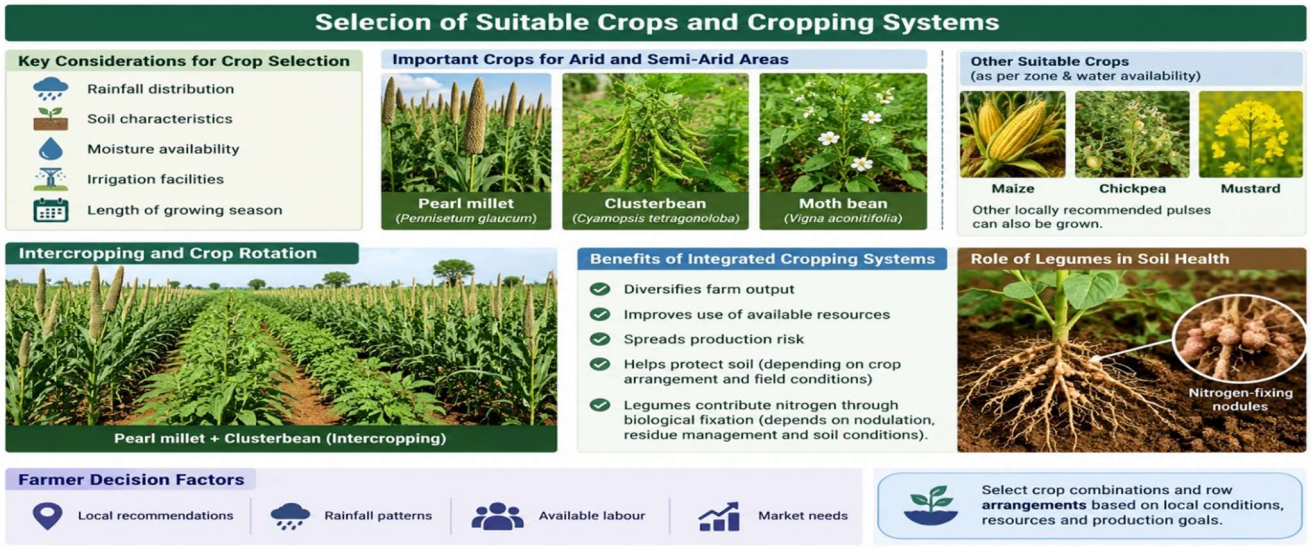


Figure 1. Selection of suitable crops and cropping systems for arid and semi-arid regions of Rajasthan.

2. Integrated Soil and Nutrient Management

Soil fertility and nutrient availability influence crop growth, yield and input-use efficiency. Soil testing helps assess pH, electrical conductivity, organic carbon and available nutrients, allowing farmers to identify deficiencies and soil-related constraints before deciding on fertilizers or amendments.

Important practices include:

- Soil testing : Test soil at recommended intervals and use the results to guide nutrient and soil-amendment decisions.
- Balanced fertilization: Apply nitrogen, phosphorus, potassium, sulphur and other nutrients according to soil-test results, crop requirements and local recommendations.
- Organic sources: Use well-decomposed farmyard manure or compost where available to add organic matter and support soil structure and biological activity.
- Legumes and biofertilizers: Include suitable legumes in rotations and use crop-specific Rhizobium inoculants where recommended.
- Micronutrients: Correct confirmed deficiencies, such as zinc or iron, using recommended sources and application methods. Select amendments for saline or sodic soils on the basis of soil-test results.
- Crop residues: Retain or incorporate suitable residues where feasible to recycle nutrients and support soil organic matter.

Integrated Nutrient Management (INM) combines mineral fertilizers with organic manures, crop residues and suitable biofertilizers. These sources are complementary, but their contributions depend on nutrient content, availability and crop demand. Fertilizer rates should not be based on a fixed formula for every field; they should follow soil-test results, crop-specific recommendations and local agricultural guidance. Nutrient management works best when coordinated

with moisture conservation and timely crop operations.

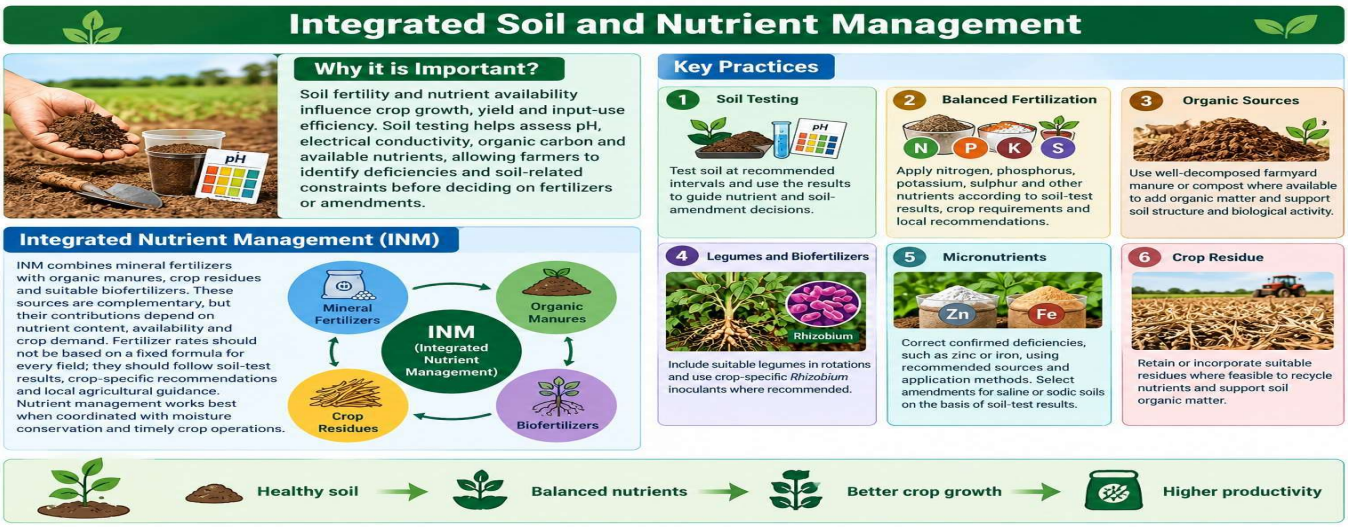


Figure 2. Integrated soil and nutrient management practices for sustainable crop production.

3. Efficient Water Management and Moisture Conservation

Rainfall in Rajasthan is often variable, dry spells can occur during the growing season, and irrigation water is limited in many areas. Water management should therefore combine rainwater harvesting, in-situ moisture conservation, appropriate irrigation scheduling and drainage where needed.

- Rainwater harvesting: Maintain suitable field bunds, farm ponds and other locally appropriate structures to reduce runoff and store water for supplemental irrigation where feasible.
- In-situ moisture conservation: Use suitable land configuration, contour bunding or other recommended measures to improve infiltration and reduce runoff on sloping or erosion-prone land.
- Efficient irrigation: Use sprinkler systems for suitable field crops and drip irrigation where appropriate, considering crop needs, soil type, water quality and installation costs.
- Mulching and residues: Retain suitable crop residues or use recommended mulch materials to reduce direct soil evaporation and moderate soil temperature.
- Irrigation scheduling: Apply water according to crop requirements, soil moisture, weather and critical growth stages. Avoid unnecessary or excessive irrigation.
- Drainage: Provide adequate drainage where required to reduce waterlogging and salt accumulation in susceptible fields.

In rainfed systems, conserving rainfall and reducing unproductive runoff can improve crop water availability. In irrigated fields, appropriate scheduling and well-maintained equipment can reduce avoidable water losses. No single practice suits every farm; selection should reflect rainfall, soil, crop, water availability and local recommendations.



Figure 3. Efficient water management and moisture conservation practices for sustainable agriculture in Rajasthan.

4. Integrated Weed Management

Weeds compete with crops for water, nutrients, light and space. Their effect depends on the crop, weed species, weed density, weather and duration of competition. Uncontrolled weeds, especially during the crop's critical period of competition, can reduce crop growth and yield. Integrated Weed Management (IWM) combines preventive, cultural, mechanical and chemical methods.

- Prevention: Use clean seed and prevent weed-seed spread through machinery, irrigation channels and contaminated residues.
- Crop establishment: Follow recommended seed rate, sowing depth and row spacing to establish a uniform crop stand.
- Crop rotation and intercropping: Use suitable systems that diversify canopy development and field operations and may suppress particular weeds.
- Manual and mechanical control: Undertake hand weeding, hoeing or mechanical control at appropriate crop and weed growth stages.
- Mulching: Use suitable residues or mulch materials where appropriate to suppress weed emergence.
- Herbicides: Use only products registered and recommended for the target crop and weed species, following label directions, dose and application timing.

The critical period of weed competition differs among crops and environments, so control timing should be crop-specific. Herbicides suitable for one crop may injure another. Combining non-chemical measures with careful herbicide use, rotating effective modes of action where appropriate and preventing weed-seed production can support long-term management and reduce resistance risk.



Figure 4. Integrated weed management practices for effective weed control and sustainable crop production.

5. Integrated Insect Pest and Disease Management

Insect pests and plant diseases can reduce crop growth, yield and produce quality. Indiscriminate pesticide use may raise costs, harm beneficial organisms, leave unwanted residues and contribute to resistance. Integrated Pest Management (IPM) combines preventive, cultural, mechanical, biological and chemical methods to keep pest populations and crop damage at acceptable levels while reducing risks to people and the environment.

- Resistant varieties: Choose varieties with documented resistance or tolerance to locally important pests and diseases where available.
- Healthy seed: Use quality-assured seed and healthy planting material. Apply recommended seed or biological treatments where appropriate.
- Field monitoring: Inspect crops regularly for pests, symptoms, beneficial organisms and changes in crop health. Confirm the cause before choosing a treatment.
- Cultural practices: Use suitable crop rotation, recommended sowing dates and crop-specific sanitation measures.
- Biological and mechanical control: Conserve natural enemies and use appropriate biological agents, traps or mechanical measures for the target pest.
- Surveillance tools: Use pheromone traps, sticky traps and other tools for the pests they are designed to monitor.
- Need-based pesticide use: Apply registered products only when justified by pest incidence, disease risk or locally recommended action thresholds. Follow label directions, protective measures and pre-harvest intervals.

Where established for a particular crop and pest, the economic threshold level can help guide control decisions. Traps are target-specific: pheromone traps generally attract particular species, while yellow sticky traps monitor certain flying insects. Neither replaces regular field scouting. Chemical control should be one part of an integrated programme, not a routine response to every pest sighting.



Figure 5. Integrated insect pest and disease management practices for sustainable crop protection.

6. Timely Sowing, Crop Establishment and Field Operations

Sowing time influences crop establishment, resource use and yield. In Rajasthan, it should be determined by crop-specific recommendations, rainfall onset and distribution, soil moisture, temperature and irrigation availability. Sowing too early or too late under unsuitable conditions may result in poor emergence, uneven plant populations or greater exposure to moisture stress, weeds, pests and diseases.

- Seed and variety: Use viable, quality-assured seed of varieties recommended for the local season and agro-climatic conditions.
- Sowing window: Follow the recommended time for each crop, considering rainfall, soil moisture and irrigation.
- Plant population: Maintain recommended seed rate, row and plant spacing, and sowing depth.

- Seed placement: Use suitable seed drills or planters where feasible to improve seed distribution and placement.
- Intercultural operations: Undertake thinning, gap filling and hoeing when required and at suitable crop stages.
- Field preparation: Prepare a suitable seedbed while avoiding unnecessary tillage that may increase costs or moisture loss.

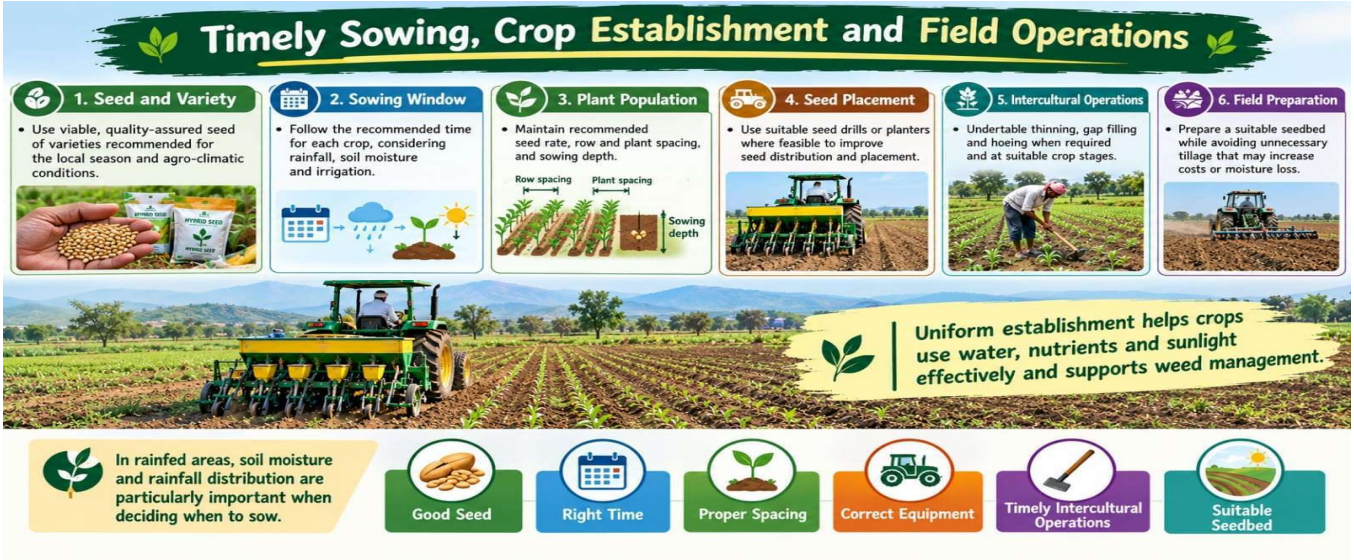


Figure 6. Timely sowing, proper crop establishment and field operations for improved crop growth and productivity in Rajasthan

Uniform establishment helps crops use water, nutrients and sunlight effectively and supports weed management. Operations should be coordinated with crop growth stages and weather conditions. In rainfed areas, soil moisture and rainfall distribution are particularly important when deciding when to sow.

7. Integrated Resource Management and Farm Economics

Efficient use of land, water, nutrients, labour, machinery and other inputs influences cultivation costs and profitability. Recycling suitable crop residues, using farmyard manure or compost where appropriate, and integrating livestock or agroforestry where suitable can diversify farm outputs and improve resource use.

- Resource recycling: Reuse suitable residues and organic materials to support nutrient cycling and reduce avoidable waste.
- Efficient input use: Plan seed, fertilizer, irrigation, plant-protection products, labour and machinery according to crop needs.
- Farm diversification: Consider crops, livestock or agroforestry according to land, water, labour, investment capacity and market opportunities.
- Record-keeping: Record input costs, labour, irrigation expenses, yield and selling prices to assess performance.
- Cost-return analysis: Calculate cultivation costs, gross returns, net returns and benefit-cost (B:C) ratio using consistent accounting methods.
- Weather-based planning: Use reliable forecasts and agricultural advisories to guide sowing, irrigation, fertilizer application, harvesting and crop protection.

Economic performance varies with yield, input prices, market access and management capacity. Farmers should compare alternatives using both agronomic performance and farm-specific costs, while considering long-term effects on soil and water resources.



Figure 7. Integrated resource management and farm economics for improving resource-use efficiency, farm profitability and long-term agricultural sustainability.

Practical Action Plan for Farmers in Rajasthan

Crop stage	Recommended management practices
Before sowing	Test soil; select suitable crops and varieties; prepare the field; check seed quality.
At sowing	Sow at the recommended time; follow seed rate, spacing and depth; treat seed where recommended.
Early crop growth	Establish a uniform crop stand; control weeds on time; apply nutrients according to crop needs.
Vegetative growth	Conserve moisture; manage nutrients; undertake intercultural operations; monitor crop health.
Flowering and reproductive stages	Irrigate at critical stages where needed; monitor pests and diseases; use need-based crop protection.
Before harvest	Assess maturity; harvest on time; arrange suitable post-harvest handling.
After harvest	Store produce safely; record yield and costs; manage residues appropriately; plan the next crop.

This action plan is a general guide. Individual practices should be adjusted to the crop, season, soil, climate, water availability and local technical recommendations.

Conclusion

Integrated Crop Management provides a practical approach to improving agricultural production in Rajasthan by combining suitable crop selection, soil-test-based nutrient management, efficient water use, timely weed control and need-based pest and disease management. Coordinating these practices can help farmers improve resource-use efficiency, avoid unnecessary input costs and maintain soil health.

The effectiveness of ICM depends on adapting practices to local soil and climatic conditions, crop requirements and available resources. Guidance from KVKs, agricultural universities and agriculture departments can help farmers adopt appropriate, science-based recommendations. Integrated Crop Management can therefore contribute to improved farm profitability and the long-term sustainability of agriculture in Rajasthan.

References

Barman, A., Pooniya, V., Choudhary, A. K., and Singh, A. 2025. Integrated crop management technology for resilient agri-food

systems and environmental stewardship. Indian Farming, **75(**12), 53-56.

Choudhary, A. K., Varatharajan, T., Rohullah, R., Bana, R. S., Pooniya, V., Dass, A., Kumar, A., and Harish, M. N. 2020. Integrated crop management technology for enhanced productivity, resource-use efficiency and soil health in legumes – A review. The Indian Journal of Agricultural Sciences, **90**(10), 1839-1849.

Indian Council of Agricultural Research (ICAR). 2026. Integrated Pest Management: A Sustainable Approach to Responsible Pest Management. https://icar.gov.in/en/integrated-pest-management-sustainable-approach-responsible-pest-management

Indian Council of Agricultural Research (ICAR). (n.d.). Rajasthan. https://www.icar.gov.in/en/node/17288

ICAR-AICRP on Pearl Millet. (n.d.). Technologies. https://www.aicpmip.res.in/technologies.html

Kumar, S., Singh, D. K., Sharma, G., Aswal, S., Dhaka, B. L., Sharma, N., and Seema. 2024. Impact of integrated crop management practices on productivity, profitability and energy budgeting of mustard in South-Eastern Rajasthan. Journal of Oilseed Brassica, **15**(1), 107-113. https://epubs.icar.org.in/index.php/JOB/article/view/157612

Volume. 1, Issue 10, October 2026

ARTIFICIAL INTELLIGENCE: A NEW HORIZON IN AGRICULTURE

Smart technologies for productive, climate-resilient and farmer-centric agriculture

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Abstract

Artificial Intelligence (AI) is creating new opportunities to improve agricultural decision-making by analysing information from weather services, soil tests, satellite imagery, sensors, field photographs and markets. Its applications include precision farming, crop-health monitoring, pest surveillance, irrigation scheduling, weather-informed crop planning and post-harvest quality assessment. India's digital agriculture initiatives including Kisan e-Mitra, the National Pest Surveillance System (NPSS) and the Digital Agriculture Mission illustrate the growing role of technology in agricultural services. These developments are especially relevant to rainfed and semi-arid regions, where the timing and distribution of rainfall strongly influence crop establishment and productivity. Yet AI is not a stand-alone solution: reliable data, local validation, affordability, farmer training and responsible data governance are essential. This article reviews key applications and Indian initiatives and discusses how AI can be integrated with agricultural research and extension to support sustainable, climate-resilient farming.

Keywords: Artificial intelligence, Agriculture 4.0, precision agriculture, digital agriculture, climate resilience, agricultural extension.

Introduction

Agriculture must increase and stabilise production while conserving soil, water and biodiversity. Indian farmers manage a range of interconnected risks: uncertain rainfall, rising input costs, pests and diseases, fragmented holdings, price fluctuations and uneven access to timely technical advice. Addressing these challenges requires more than new machinery or improved varieties; it also requires better decisions about when, where and how to use available resources.

Artificial Intelligence refers to computational methods that identify patterns in data, interpret images, generate predictions and support decisions. In agriculture, AI can combine information from satellites, weather forecasts, soil sensors, field observations and historical records to provide timely, location-specific insights. When linked with the Internet of Things (IoT), drones, mobile applications and digital advisory services, AI becomes part of the wider transition commonly described as Agriculture 4.0.

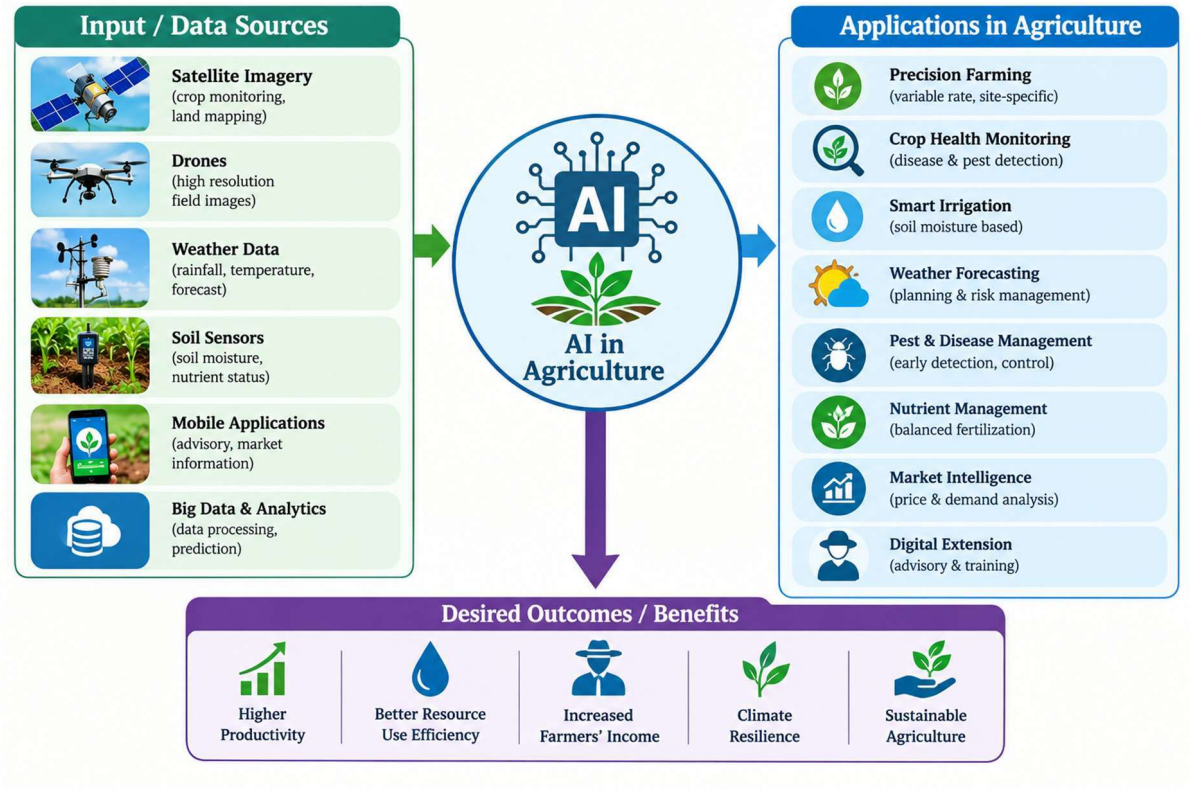


Fig.1. Artificial Intelligence in Agriculture: Key Inputs, Applications and Benefits

From Data to Decisions: How AI Can Support Farming

An AI-enabled agricultural service typically follows a cycle: collecting data, analysing patterns, generating an advisory, implementing a suitable field action and using feedback to improve the service. Data may include rainfall forecasts, soil characteristics, crop-stage observations, photographs of pests, satellite-derived crop indicators and market information. The quality and relevance of the recommendation depend on the accuracy of these inputs and on whether the model has been tested in the target region.

A model developed for one crop, soil or climatic region may not perform equally well elsewhere. Therefore, local calibration, independent field validation and clear communication of uncertainty are essential before recommendations are widely promoted.

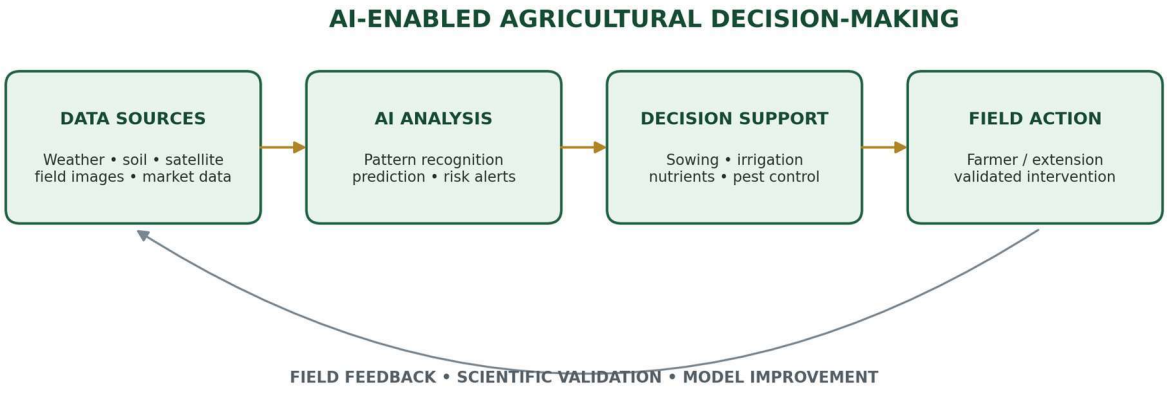


Figure 2. Conceptual framework for AI-enabled agricultural decision-making. The cycle requires field feedback and scientific validation.

Major Applications of AI in Agriculture

1. Precision agriculture and site-specific input management

Fields often show spatial variation in soil texture, fertility, water-holding capacity and crop growth. AI can analyse satellite or drone imagery alongside soil-test and yield data to identify zones with different management needs. Where suitable equipment and reliable data are available, these insights may support variable-rate application of fertilizers, targeted scouting and more efficient input use. Benefits should be assessed through field comparisons, including input costs, yield and profitability.

2. Crop-health monitoring and pest management

AI-based image-recognition tools can help screen photographs of leaves, stems, fruits or insects for symptoms associated with pests, diseases and nutrient disorders. Satellite and drone observations can flag patches of abnormal crop growth for closer inspection. Such tools can help extension workers prioritise visits and may support early intervention, but an image-based result should not automatically be treated as a confirmed diagnosis. Field verification, pest thresholds and integrated pest-management principles remain necessary.

3. Weather-informed crop planning

Rainfall timing and distribution influence sowing, crop establishment, fertilizer response and harvesting. AI-based analysis can combine weather forecasts, historical records and crop-stage information to provide decision support for sowing windows, irrigation planning and risk alerts. Forecasts are probabilistic, however, and should be presented with uncertainty rather than as guarantees. Farmers should use them alongside local observations and advisories from competent agricultural and meteorological agencies.

4. Irrigation and soil-moisture management

Sensor-based systems can combine soil-moisture readings, weather conditions and crop water requirements to guide irrigation scheduling. In rainfed regions, data-driven advisories may also help plan moisture-conservation operations and make better use of limited supplemental irrigation. AI can complement established practices such as in-situ moisture conservation, suitable land configuration, mulching and efficient irrigation; it cannot replace sound soil and water management or create water where supplies are inadequate.

5. Post-harvest management and markets

Machine vision can support grading of produce by size, colour and visible defects, while data analytics can assist inventory management, demand estimation and transport planning. Market information tools may help farmers and Farmer Producer Organisations compare prices and identify potential selling opportunities. Outcomes still depend on transparent information, functioning markets, storage, transport and farmers' bargaining capacity.

Table 1. Agricultural applications of AI and their potential contribution

Application	AI-enabled approach	Potential contribution
Crop planning	Weather, soil and crop-history analysis	Better-informed sowing and crop choices
Crop monitoring	Satellite/drone image analysis	Early flagging of crop stress
Pest surveillance	Image recognition and risk alerts	Timely field scouting and targeted response
Irrigation	Soil moisture + weather + crop stage	Improved irrigation scheduling
Nutrient management	Soil-test and crop-requirement analysis	More balanced input decisions
Post-harvest	Machine vision and quality classification	Consistent grading and handling
Extension	Voice-based multilingual services	Wider access to information

*Source: Compiled from Government of India publications and the August 2025 *Kurukshetra* issue on Agritech.*

Indian Initiatives: Moving Digital Agriculture into Practice

Kisan e-Mitra is a voice-based AI chatbot developed to answer farmers queries related to the PM-KISAN scheme and other government services. In a Press Information Bureau release dated 22 July 2025, the Ministry of Agriculture and Farmers' Welfare reported that it supported 11 regional languages, handled more than 20,000 queries daily and had answered over 95

lakh queries. These figures are a dated official snapshot, not a permanent or current total.

The National Pest Surveillance System (NPSS), launched on 15 August 2024, uses AI and machine learning to support pest and crop-health surveillance. A PIB release dated 1 April 2025 reported that the platform was being used by more than 10,000 extension workers and supported 61 crops and over 400 pests at that time. These dated figures illustrate the scale of the programme as reported in 2025.

The Digital Agriculture Mission, approved in September 2024 with a total outlay of ₹2,817 crore, aims to strengthen digital public infrastructure for agriculture, including AgriStack and the Krishi Decision Support System. Such infrastructure can help connect agricultural datasets and improve the delivery of digital services. The usefulness of these initiatives ultimately depends on data quality, interoperability, safeguards for farmers and the ability to convert digital outputs into actionable field advice.

Opportunities for Rainfed and Semi-Arid Agriculture in Rajasthan

AI has particular relevance to rainfed and semi-arid agricultural systems of Rajasthan, where rainfall variability, limited water availability and soil-moisture stress can influence crop establishment and yield. In districts such as Bhilwara and surrounding areas, locally validated advisory systems could combine rainfall forecasts, soil characteristics, crop-stage information and field observations.

For *kharif* crops, weather-informed advisories may help farmers assess sowing opportunities and plan early-season operations. Soil-moisture observations and crop-stage information may support decisions about conservation practices or limited supplemental irrigation. Image-based crop monitoring may help extension personnel identify suspicious patches and prioritise field visits. These services should be designed for local languages and the realities of smallholder farming.

AI could also support comparisons among alternative cropping systems by organising information on crop water requirements, soil suitability, expected returns and local markets. For example, choices within maize-based systems should be assessed through locally relevant field trials and economic analysis rather than generic recommendations. Agricultural universities, research stations, Krishi Vigyan Kendras and extension agencies can play a key role in building datasets, validating outputs and training farmers.

Limitations, Ethics and the Way Forward

The adoption of AI faces several constraints. Incomplete or biased datasets can reduce reliability, while weak connectivity, device costs and limited digital literacy may exclude farmers who could benefit from advisory services. Models can also fail when transferred to a different region or crop without validation. Data ownership, privacy, consent and accountability must be addressed transparently. In addition, an AI-generated recommendation should not be followed blindly where it conflicts with field conditions or established safety guidance.

1. **Scientific validation:** test tools through replicated trials, multi-location demonstrations and independent performance assessment.
2. **Local relevance:** develop datasets for regional crops, soils, climates and languages, and update them as conditions change.
3. **Affordable access:** explore shared services through FPOs, cooperatives, custom-hiring centres and extension institutions.
4. **Capacity building:** train farmers and extension personnel to interpret advisories and understand uncertainty.
5. **Measurable outcomes:** assess yield, net returns, input use, water-use efficiency, farmer satisfaction and unintended effects.

The most effective approach is a partnership among farmers, scientists, extension workers, public agencies and technology developers. AI systems should be evaluated not only by technical accuracy but also by whether they deliver practical, affordable and equitable benefits in the field.

Conclusion

Artificial Intelligence is opening a new horizon for agriculture through precision management, crop-health monitoring, pest surveillance, weather-informed planning, irrigation support and improved post-harvest operations. Indian initiatives such as Kisan e-Mitra, NPSS and the Digital Agriculture Mission demonstrate the growing integration of digital technologies into agricultural services. For Rajasthan's rainfed farming systems, AI can help organise complex information and support better-informed decisions on sowing, moisture conservation, crop diversification and resource use. Yet technology alone cannot ensure sustainability. Reliable data, local validation, farmer participation, affordability and responsible governance are indispensable. The real promise of AI is not simply to automate farm operations,

but to empower farmers and agricultural institutions with timely, credible and actionable information.

References

1. Patel, N. and Banafar, P. (2025). Agriculture 4.0: Towards Agri-Tech Revolution. Kurukshetra: A Rural Development Monthly, 73(10), August 2025, p. 5 onwards. Publications Division, Government of India. Issue contents: https://jammuuniversity.ac.in/sites/default/files/inline
2. Ministry of Agriculture and Farmers' Welfare, Government of India. (2025, 22 July). Promotion of Agriculture through Artificial Intelligence Technology. Press Information Bureau. https://www.pib.gov.in/PressReleasePage
3. Ministry of Agriculture and Farmers' Welfare, Government of India. (2025, 1 April). Kisan e-Mitra and IoT enabled systems to improve crop productivity. Press Information Bureau. https://www.pib.gov.in

1. Ministry of Agriculture and Farmers' Welfare, Government of India. (2025, 7 February). Use of AI in agriculture. Press Information Bureau. https://www.pib.gov.in/Pressreleaseshare.
2. Ministry of Agriculture and Farmers' Welfare, Government of India. (2024, 17 September). Cabinet approves Digital Agriculture Mission. Press Information Bureau. https://www.pib.gov.in/
3. Publications Division, Ministry of Information and Broadcasting, Government of India. (2025). Kurukshetra, August 2025: Agritech issue page. https://www.publicationsdivision.nic.in

Volume. 1, Issue 10, October 2026

STRUCTURAL TRANSFORMATION AND GROWTH DYNAMICS OF GUJARAT'S AGRICULTURAL SECTOR

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Introduction

Agriculture and allied activities have remained central to Gujarat's economic development, rural livelihoods, and diversification. Over the past four decades, the state's agricultural economy has undergone significant structural transformation, shifting gradually from traditional crop-based production to high-value crops and allied activities. Changes in irrigation, technological advancement, market infrastructure, commercialization, changing consumer demand and diversification of farm activities have contributed to this transformation. While cereals, pulses and oilseeds historically constituted an important component of agricultural production, the increasing importance of fruits and vegetables, spices and condiments, dairy, forestry and fisheries reflects the changing composition of agricultural output. Such changes are important not only for understanding the growth trajectory of Gujarat's agriculture but also for assessing the emerging sources of agricultural income and value creation. The increasing contribution of livestock and other allied activities suggests that agricultural development in the state is progressively becoming more diversified and less dependent on conventional crop production.

The growth trajectory, however, has not been uniform across different periods or commodity groups. From 1980-81 to 2023-24, Gujarat state agriculture has transformed towards high-value crops, livestock, forestry and fishing due to policy implications, demand of the products and institutional changes. Therefore, the present study examines the changing composition, growth performance and contribution of major commodity groups to the value of output growth of Gujarat's agriculture and allied sector during 1980-81 to 2023-24. The study specifically analyses the changing share of different commodity groups, period-wise growth rates and their commodity group contribution to overall growth of the sector. The analysis provides evidence of the evolving structure of Gujarat's agricultural economy and highlights the increasing role of diversification, commercialization and high-value agricultural and allied activities in shaping the state's agricultural growth.

The study is based on secondary data from a period of 1980-81 to 2023-24. Data on the value of output of major commodity groups and agriculture and allied activities were obtained from the Ministry of Statistics and Programme Implementation (MoSPI, 2026). The analysis covers major crop groups, including cereals, pulses, oilseeds, sugar, fibre, spices and condiments, fruits and vegetables and other crops, along with milk, other livestock, forestry and fisheries. The analysis uses three major indicators: (i) commodity group-wise share in the value of output, (ii) growth rate of value of output, and (iii) contribution of individual commodity groups to the overall growth of agriculture and allied activities. The study period is divided into four sub-periods 1980-81 to 1989-90, 1990-91 to 1999-00, 2000-01 to 2009-10 and 2010-11 to 2023-24 to examine changes in growth and structural composition over time. Growth rates are estimated using the appropriate growth-rate approach based on the time-series value of output. The contribution of individual commodity groups is assessed to identify their relative role in determining the overall growth of the agriculture and allied sector. Wholesale Price Index (WPI) data, wherever required for price-related analysis, are sourced from the Office of the Economic Adviser. The analysis is conducted at constant prices to distinguish changes in real output from changes attributable to price movements.

Results and discussion

Gujarat state agriculture and allied sector has gone through a significant structural transformation throughout the period 1980-81 to 2023-24. The share of crop sector declined from 76.52 per cent during the 1990s to 61.98 per cent during 2010-11 to 2023-24, indicating a gradual shift toward livestock, forestry, and fisheries (Fig. I). Crops contributed 57.69 per cent of the total value of output for the entire period, followed by livestock, forestry and fisheries at 26.28, 10.13 and 5.90 per cent respectively. Cereals and oilseeds saw the biggest decrease in their relative value of output contributions within the crop sector. The share of cereals decreased from 21.22 per cent in the 1980s to 6.35 per cent during 2010-11 to 2023-24 and oilseeds from 25.51 to 11.54 per cent in 2010-11 to 2023-24. Pulses also fell from 5.02 to 2.26 per cent. Sugar fell from 5.46 to 1.87 per cent. However, fruits and vegetables share increased from 10.52 per cent in the 1980s to 15.60 per cent during 2010-11 to 2023-24 in the total value of output. The share of spices and condiments also increased from 3.50 per cent to 5.29 per cent, indicating the increase in diversification into high-value crops.

The shares of the fiber crops were still varying along the lines of 11 to 12 per cent over the two successive periods. In contrast, livestock, mainly for milk (21.73 per cent), has emerged as a major constituent, rising from 23.48 per cent in the 1990s to 25.52 per cent in the latest period. The share of forestry and fisheries increased from 11.83 per cent (2000-01 to 2009-10) to 12.49 per cent in the latest period. Overall, the results reveal a distinct transition in the agricultural economy, from traditional cereal and oilseed agriculture to high-value crops and allied activities such as fruits and vegetables, dairy, forestry and fisheries. This indicates the changing structure of the state's agricultural economy in terms of commercialization, diversification and higher value crops.

The growth performance of the agriculture and allied sector in Gujarat shows a pattern of improvement over time, with a relatively weak performance in the 1980s and strong acceleration in the subsequent decades (Table 1). The crop sector experienced a negative growth rate of -2.55% from 1980-81 to 1989-90, mainly due to the decline in the growth rate of major crop groups like cereals (-5.84%), fiber (-8.28%), pulses (-2.30%) and oilseeds (-2.73%). This poor performance is attributed to greater dependence on rain, frequent droughts and climatic variability, low adoption of modern agricultural technologies, low irrigation coverage, low productivity during the initial period, etc. The negative growth is primarily due to the decrease in real agricultural output and not to price changes, as the figures are based on the value of output at constant prices of 2011-12.

Table 1: Commodity group-wise growth of Value of Output

(Base year, 2011-12)

Commodity Groups	1980-81 to 1989-90	1990-91 to 1999-00	2000-01 to 2009-10	2010-11 to 2023-24	1980-81 to 2023-24
Cereals	-5.84	2.63	8.97	2.43	3.01
Pulses	-2.30	0.84	11.07	10.80	3.97
Oilseeds	-2.73	2.70	9.42	4.78	4.38
Sugar	-0.04	4.27	1.04	4.63	3.21
Fibre	-8.28	10.81	23.80	-0.31	6.80
Spices & Condiments	-0.60	1.95	18.05	11.07	8.00
Fruits & Vegetables	2.57	5.10	14.78	6.51	8.12
Other Crops	-1.00	6.52	1.44	5.22	4.19
Crop Sector	**-2.55**	**4.87**	**10.55**	**4.53**	**5.29**
Milk	-	6.46	7.56	7.30	7.39
Other livestock	-	7.69	15.45	2.74	7.77
Livestock Sector	-	**6.62**	**8.66**	**6.60**	**7.45**
Forestry	-	-	31.35	10.95	13.69
Fisheries	-	-	5.15	9.35	6.80

Commodity Groups	1980-81 to 1989-90	1990-91 to 1999-00	2000-01 to 2009-10	2010-11 to 2023-24	1980-81 to 2023-24
Forestry & Fisheries Sector	-	-	**16.02**	**10.39**	**9.73**
Agriculture and Allied Activities	**-2.55**	**5.79**	**10.61**	**5.65**	**6.72**

Source: MOSPI, 2026

The crop sector recorded a growth of 4.87 per cent during 1990-91 to 1999-00, which rose to 10.55 per cent during 2000-01 to 2009-10 and moderated in the period of 2010-11 to 2023-24 at 4.53 per cent. The highest growth during 2000-01 to 2009-10 was recorded for fiber crops (23.80%) followed by spices and condiments (18.05%) and fruits and vegetables (14.78%). The important high-growth crop groups for the entire period have been spices and condiments (8.00%) and fruits and vegetables (8.12%), signifying a shift toward high-value agriculture.

The livestock sector also increased consistently from a growth rate 6.62 per cent in the 1990s to 8.66 per cent in 2000-01 to 2009-10, with an overall growth rate of 7.45 per cent. Forestry and fisheries also contributed substantially, with growth of 9.73 per cent during the longer period also. Agriculture and allied activities overall grew at 6.72 per cent per annum. This reflects structural changes and diversification of the Gujarat agricultural economy away from traditional crop-based production toward high-value crops, livestock, forestry and fisheries.

The contribution pattern, when viewed alongside the growth rates, highlights a transformation in the sources of agricultural growth in Gujarat (Table 2). During the 1980s, Gujarat's agricultural sector experienced a contraction of 2.55 per cent annually, primarily due to negative growth in cereals (-5.84%), fibre (-8.28%), and oilseeds (-2.73%). Negative growth in these three groups pulled overall growth down, with contributions of −48.69, −38.36 and −27.36 per cent respectively. Pulses and other crops also recorded negative growth of 2.30 and 1.00 per cent, contributing -4.54 and -6.69 per cent, respectively. In contrast, fruits and vegetables registered positive growth of 2.57 per cent and contributed 10.62 per cent, indicating their relatively better performance during this period. During the 1990s, agricultural growth recovered to 4.87 per cent, supported by a turnaround in most crop groups. Fibre recorded a strong growth of 10.81 per cent and it contributed by 21.09 per cent in the growth of agriculture and allied sector, while other crops, oilseeds and fruits and vegetables increased by 6.52, 2.70 and 5.10 per cent, contributing 12.03, 9.08 and 8.82 per cent in the growth of the agriculture and allied sector, respectively. The livestock sector also increased by 6.62 per cent, with a contribution of 22.53 per cent to overall growth of the sector. This indicates the beginning of a shift towards commercial crops, high-value crops and livestock activities.

Table 2: Commodity Group-Wise Contribution to the Growth of Value of Output

(Base year, 2011-12)

Commodity Groups	1980-81 to 1989-90	1990-91 to 1999-00	2000-01 to 2009-10	2010-11 to 2023-24	1980-81 to 2023-24
Cereals	-48.69	5.91	7.46	2.73	3.24
Pulses	-4.54	0.58	2.23	4.32	1.32
Oilseeds	-27.36	9.08	12.61	9.76	7.74
Sugar	-0.08	3.74	0.42	1.53	1.19
Fibre	-38.36	21.09	26.37	-0.64	10.36
Spices & Condiments	-0.82	1.00	4.52	10.36	4.62
Fruits & Vegetables	10.62	8.82	16.72	17.97	14.80
Other Crops	-6.69	12.03	1.32	6.71	4.68
Milk	-	22.53	13.65	28.08	24.65
Other livestock	-	4.38	4.88	1.84	4.49
Forestry	-	-	20.62	15.71	20.66

Commodity Groups	1980-81 to 1989-90	1990-91 to 1999-00	2000-01 to 2009-10	2010-11 to 2023-24	1980-81 to 2023-24
Fisheries	-	-	2.36	7.27	5.97

Source: MOSPI, 2026

During 2000-01 to 2009-10, agricultural and allied activities recorded their highest growth of 10.61 per cent, driven by rapid expansion across several commodity groups. Fibre registered the highest crop growth of 23.80 per cent and contributed 26.37 per cent to overall growth, followed by fruits and vegetables (14.78% growth; 16.72% contribution), oilseeds (9.42%; 12.61%) and milk (7.56%; 13.65%). Forestry recorded exceptionally high growth of 31.35 per cent, contributing 20.62 per cent. The growth during this period reflects a significant phase of agricultural diversification and expansion of high-value and allied activities. During 2010-11 to 2023-24, the growth of agriculture and allied activities moderated to 5.65 per cent, although several high-value and allied commodities continued to perform strongly. Milk recorded 7.30 per cent growth and emerged as the largest contributor, accounting for 28.08 per cent of overall growth, followed by fruits and vegetables (6.51% growth; 17.97% contribution) and forestry (10.95%; 15.71%). Spices and condiments also recorded strong growth of 11.07 per cent, while fisheries grew by 9.35 per cent. In contrast, fibre experienced a marginal decline of 0.31 per cent.

Over the entire 1980-81 to 2023-24 period, Gujarat's agriculture and allied sector registered an average growth of 6.72 per cent, with the crop sector growing by 5.29 per cent, livestock by 7.45 per cent, and forestry and fisheries by 9.73 per cent. Among individual commodity groups, fruits and vegetables recorded 8.12 per cent growth and contributed 14.80 per cent, while milk registered 7.39 per cent growth and contributed 24.65 per cent. Forestry, with 13.69 per cent growth, contributed 20.66 per cent, while fibre and oilseeds contributed 10.36 and 7.74 per cent, respectively. Overall, the results indicate a structural transformation of Gujarat's agriculture from dependence on traditional crops towards high-value crops, dairy, forestry and fisheries, reflecting increasing diversification and commercialization of the agricultural economy.

Conclusions

The study reveals a significant structural transformation in Gujarat's agriculture and allied sector during 1980-81 to 2023-24. The share of the crop sector declined over time, while livestock, forestry and fisheries gained increasing importance. The 1980s recorded negative agricultural growth, largely because the period was affected by droughts and rainfall variability, which adversely affected crop production, particularly cereals, fibre and oilseeds. Growth improved substantially during the subsequent decades, reaching its highest level during 2000-01 to 2009-10, supported by the expansion of fibre, fruits and vegetables, livestock and forestry. In the recent period, dairy, fruits and vegetables, spices, forestry and fisheries have emerged as important drivers of growth. Overall, the findings indicate a clear shift from traditional cereal- and oilseed-oriented agriculture towards high-value crops and allied activities. This transformation highlights the growing importance of agricultural diversification, commercialization, improved irrigation and technological advancement in strengthening the resilience and growth of Gujarat's agricultural economy.

References

MOSPI. 2026. Ministry of Statistics and Programme Implementation, Government of India, New Delhi. https://www.mospi.gov.in/.

OEA. 2026. Office of The Economic Adviser, Department for Promotion of Industry and Internal Trade, Ministry of Commerce & Industry, Government of India, New Delhi. https://eaindustry.nic.in/.

Volume. 1, Issue 10, October 2026

THE HIDDEN UNIVERSE BENEATH OUR FEET:

HOW METAGENOMICS UNVEILS THE SECRETS OF NATURAL FARMING

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Soil is not merely a medium for anchoring plant roots, it is a vibrant ecosystem inhabited by billions of microorganisms. These microorganisms influence nutrient availability, the decomposition of organic matter, plant health, and the resilience of the ecosystem. The goal of natural farming is to promote sustainable agricultural production by harnessing ecological processes and locally available resources. However, a significant portion of the microbial world, which underpins these processes, remains invisible to the naked eye. Metagenomics, an advanced DNA-based technique, offers an opportunity to explore this hidden world by analyzing genetic material obtained directly from environmental samples. By uncovering the diversity and functionality of soil microbial communities, metagenomics can help researchers understand how natural farming practices affect soil health, as well as the interactions between plants and microorganisms. This paves the way for evidence-based and sustainable agricultural management (Badiyal et al., 2024; Gajjar et al., 2026a).

Discovering the Invisible Workforce Beneath Our Feet

A single handful of soil can contain an incredibly diverse community of bacteria, fungi, archaea, and other microorganisms. These organisms interact with plant roots, organic matter, and each other, facilitating biological processes that sustain agricultural ecosystems. Some microorganisms participate in nitrogen fixation, the solubilization of phosphorus, the decomposition of organic matter, and the cycling of essential nutrients. Others can help plants withstand environmental stress or suppress certain soil-borne pathogens. However, their abundance and activities vary depending on soil properties, climate, crop varieties, and farming practices. Through metagenomics, scientists can study microbial communities without needing to cultivate each organism individually in a laboratory. This expands our understanding of soil biodiversity and its ecological significance (Clagnan et al., 2024).

Metagenomics: Reading the Genetic Language of Soil

Traditional microbiological methods have provided valuable information about soil microorganisms. However, many of these organisms are difficult to cultivate under standard laboratory conditions. Metagenomics overcomes this limitation by analyzing DNA extracted directly from soil, the rhizosphere, compost, and other environmental samples. In shotgun metagenomic sequencing, DNA fragments from various organisms are sequenced and analyzed using bioinformatics tools to identify microbial communities and investigate genes associated with specific biological functions. Such analyses can reveal the genetic potential related to nutrient cycling, carbohydrate decomposition, stress responses, and interactions between plants and microorganisms. Importantly, the detection of a gene indicates potential functionality, but it does not prove that the corresponding process is actually occurring under field conditions. Integrating metagenomic findings with soil measurements, microbial activity assays, and field experiments provides a more comprehensive understanding of the soil ecosystem (Clagnan et al., 2024; Jagadesh et al., 2024).

Natural Farming: An Exploration of Microbial Foundations

Natural farming methods often emphasize biological processes, locally available resources, crop diversity, mulching (covering the soil), and the recycling of organic matter. These practices can influence soil moisture, the availability of organic matter, the

environment surrounding plant roots, and the resources accessible to microorganisms. Metagenomics provides a means to compare microbial communities across natural and conventional farming systems, helping researchers determine whether specific agricultural practices induce changes in microbial diversity and functionality.

In India, natural farming inputs such as beejamrut, jeevamrut, ghanjeevamrut, and panchagavya offer opportunities to investigate microbial characteristics and evaluate their effects scientifically. Under the Network Research Program on Bharatiya Prakritik Krishi Paddhati (Natural Farming) through Biotechnology Interventions, supported by the Gujarat State Biotechnology Mission, Department of Science and Technology, Government of Gujarat, metagenomics and microbial studies have been identified as key tools for investigating the interactions between natural farming inputs and soil microorganisms (https://btm.gujarat.gov.in/Natural-Farming.htm). Nevertheless, establishing the efficacy of different formulations and practices requires appropriate experimental controls, standardized protocols, and crop-specific field validation (Gajjar et al., 2025; Jain et al., 2026).

Unlocking Nutrient Cycling and Soil Fertility

Healthy soil resources are tested for their potential use as components in bio-fertilizers or microbial consortia (groups of microorganisms). However, the mere presence of functional genes does not determine the rate at which nutrients will be released, nor the total quantity of nutrients that will ultimately become available to crops. Chemical soil analysis, enzymatic assays, and field measurements remain essential for translating genetic information into practical recommendations (Clagnan et al., 2024).

Strengthening Plant Health through Beneficial Microbes

Plants and microorganisms maintain complex relationships in and around their roots. The narrow zone of soil influenced by root exudates, known as the rhizosphere, provides a dynamic environment where microorganisms compete, cooperate, and interact with plants. Certain bacteria and fungi can promote plant growth, enhance nutrient uptake, produce biologically active compounds, or contribute to protection against specific pathogens. Metagenomics can assist researchers in identifying the microbial groups and genes associated with these functions, while comparative studies can reveal how agricultural practices influence plant-associated microbial communities. Such findings can facilitate the development of locally adapted microbial inoculants and biologically informed crop management strategies. However, these beneficial effects are often strain-specific and depend on interactions with the plant genotype, soil conditions, climate, and existing microbial communities. Therefore, potential organisms identified through metagenomics should be isolated or otherwise characterized and their safety, efficacy, and field performance must be evaluated before they are put to practical use (Jagadesh et al., 2024).

Decoding Natural Farming Inputs through DNA Sequencing

Traditional natural farming practices involve mixtures of organic substances, the microbial composition of which can vary depending on the ingredients used, preparation methods, storage conditions, and the local environment. Metagenomics offers an opportunity to study the microbial diversity within these preparations and investigate their potential biological functions. Comparing preparations made using different ingredients or fermentation conditions can help researchers identify consistent microbial patterns and understand how preparation processes influence microbial communities. For instance, studies on Jeevamrut, Ghanjeevamrut, and other locally used preparations can reveal the presence of microorganisms involved in nutrient cycling or the promotion of plant growth (Gajjar et al., 2026b). Such research can also assist in identifying undesirable microorganisms and improving quality control procedures. Nevertheless, the identification of a potentially beneficial microorganism does not automatically confirm the efficacy of a preparation. Factors such as microbial viability, metabolic output, safety, reproducibility, and performance under field conditions must also be evaluated.

Bioinformatics and Artificial Intelligence: Turning DNA Data into Agricultural Insights

Metagenomic sequencing generates vast amounts of DNA sequence data, which require specialized computational approaches for meaningful analysis. Bioinformatics pipelines assist researchers in assessing sequence quality, classifying microorganisms, assembling DNA fragments, predicting genes, and comparing functional profiles within soil samples. Public databases and reference genomes are instrumental in identifying microbial communities and annotating genes associated with key biological processes. Machine learning can complement these approaches by uncovering relationships between microbial profiles, soil characteristics, agricultural practices, and crop performance. Given sufficiently large, representative,

and well-validated datasets, predictive models could eventually help identify microbial indicators of soil health or distinguish between management systems based on their microbial signatures. However, computational predictions are contingent upon data quality and rigorous validation. Artificial intelligence cannot compensate for poorly designed experiments, nor can it serve as a substitute for field-based evidence (Kumar et al., 2026).

Building Climate-Resilient and Sustainable Farming Systems

Climate change exposes agricultural systems to mounting challenges, including drought, salinity, heat, and erratic rainfall. Soil microorganisms can contribute to ecosystem resilience through processes such as nutrient transformation, the decomposition of organic matter, plant-microbe interactions, and other ecological functions. Metagenomics can help researchers understand how microbial communities respond to these stressors and identify specific genes or organisms that warrant further evaluation for their potential role in plant adaptation. Comparing agricultural systems across diverse agro-climatic zones may also reveal whether certain microbial characteristics are consistently associated with healthy soil or more resilient crops. Such insights could inform the development of site-specific management strategies that integrate biological resources with soil testing and agronomic knowledge. While microbiome-based approaches hold significant promise, their benefits must be demonstrated through long-term, multi-location trials before they can be recommended for widespread adoption (Gajjar et al., 2026a).

Challenges and the Road Ahead

Despite its potential, metagenomics faces several scientific and practical challenges. Microbial communities in soil are highly diverse, and their composition varies according to location, season, crop variety, and soil depth. Processes for DNA extraction, sequencing technologies, reference databases, and bioinformatics pipelines can also influence the results. Furthermore, DNA-based analyses may detect genetic material from inactive or dead organisms. Moreover, the abundance of a gene does not necessarily indicate that it is active or performing a biological function. Factors such as the cost of sequencing, the need for computational expertise, and the limited availability of reference data specific to a given region can also hinder the adoption of these techniques. Integrating metagenomics with metatranscriptomics, metabolomics, microbial cultivation, soil health assessments, and carefully designed field experiments can help bridge the gap between genetic potential and the actual functioning of an ecosystem. Collaboration among microbiologists, bioinformaticians, agricultural experts, and farmers will be crucial for translating microbial discoveries into reliable and locally applicable agricultural solutions (Gajjar et al., 2026b).

Conclusion

Metagenomics is unveiling a new world, a hidden biological realm that sustains agricultural soils. By shedding light on microbial diversity and the genetic potential of soil- and plant-associated communities, this technology can deepen our understanding of nutrient cycling, plant health, and the ecological processes influenced by natural farming practices. Applying metagenomics to natural farming inputs and soil ecosystems can assist researchers in identifying promising microorganisms, developing improved assessment methods, and formulating evidence-based approaches for soil management. When integrated with bioinformatics, artificial intelligence, conventional soil testing, and field validation, metagenomics can contribute to a more comprehensive understanding of sustainable agriculture. Its ultimate potential lies not merely in the discovery of more microorganisms, but in understanding how microbial communities function within actual agricultural systems, and how this knowledge can support productive, resilient, and environmentally responsible agriculture.

References

Badiyal, A., Mahajan, R., Rana, R.S., Sood, R., Walia, A., Rana, T., Manhas, S. and Jayswal, D.K., 2024. Synergizing biotechnology and natural farming: pioneering agricultural sustainability through innovative interventions. Frontiers in plant science, 15, p.1280846.

Clagnan, E., Costanzo, M., Visca, A., Di Gregorio, L., Tabacchioni, S., Colantoni, E., Sevi, F., Sbarra, F., Bindo, A., Nolfi, L. and Magarelli, R.A., 2024. Culturomics-and metagenomics-based insights into the soil microbiome preservation and application for sustainable agriculture. Frontiers in Microbiology, 15, p. 1473666.

Gajjar, K., Chaudhary, M., Patel, S., Vasa, N., Maniyar, R., Agrawal, D., Patel, C.K., Chaudhary, D., Joshi, C., Joshi, M. and Dharajiya, D., 2026a. Natural farming as a sustainable agricultural approach enhances soil health and microbial diversity in wheat cultivation: a metagenomic perspective. Frontiers in Agronomy, 8, p.1755662.

Gajjar, K., Panchal, D., Chaudhary, M., Raval, I., Chaudhary, D., Patel, C.K., Bagatharia, S., Joshi, C., Patel, A. and Dharajiya, D., 2026b. Multi-omics characterization of microbial and metabolite profiles of Jeevamrit and Ghanjeevamrit cow-based bioformulations used in sustainable agriculture. Scientific Reports, 16, 20444.

Gajjar, K., Patel, S., Chaudhary, M., Agrawal, D., Maniyar, R., Chaudhary, D., Patel, C.K., Joshi, C., Joshi, M. and Dharajiya, D., 2025. Metagenomic insights reveal the impact of natural

farming on soil nutrients, enzyme activities, microbial communities, and yield in turmeric cultivation. BMC Plant Biology, 26(1), p.28.

Jagadesh, M., Dash, M., Kumari, A., Singh, S.K., Verma, K.K., Kumar, P., Bhatt, R. and Sharma, S.K., 2024. Revealing the hidden world of soil microbes: metagenomic insights into plant, bacteria, and fungi interactions for sustainable agriculture and ecosystem restoration. Microbiological Research, 285, p. 127764.

Jain, A.G., Agwan, D., Kumar, A., Pancha, I., Rathod, J. and Mohapatra, B., 2026. Mixing regimes shape microbial community composition, nutrient regimes, and plant growth attributes in Jeevamrit: metagenomics and culturomics-based insights. Scientific Reports, 16(1), p.6603.

Kumar, P., Sharma, S., Sharma, S., Verma, S. and Chandel, R.S., 2026. Predictive bioinformatics models in natural farming practices-bridging science and sustainability. Environmental Sustainability, pp.1-12.

NOVEMBER MAGAZINE

IMPORTANT DAYS IN NOVEMBER

Agriculture, Environment, Health and Rural Development

1 NOVEMBER — World Vegan Day

Promotes veganism and a plant-based lifestyle to improve health, protect animals and reduce environmental impact.



6 NOVEMBER — International Day for Preventing the Exploitation of the Environment in War and Armed Conflict

Raises awareness of the serious, long-term impact of environmental damage caused by war and armed conflict.



10 NOVEMBER — World Science Day for Peace and Development

Highlights the important role of science in achieving peace, sustainable development and improving lives.



14 NOVEMBER — World Diabetes Day

Raises awareness about diabetes, its prevention, management and the importance of a healthy lifestyle.



19 NOVEMBER — World Toilet Day

Promotes the maturation and hygiene for all, emphasizing the dignity and health benefits of clean toilets.



21 NOVEMBER — World Fisheries Day

Celebrates the vital role of fisheries and aquaculture in food security, livelihoods and sustainable use of water resources.



25 NOVEMBER — International Day for the Elimination of Violence against Women

Calls for the elimination of violence against women and girls and promotes equality, respect and human rights.



26 NOVEMBER — National Milk Day (India)

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Volume. 1, Issue 2, Februay 20261