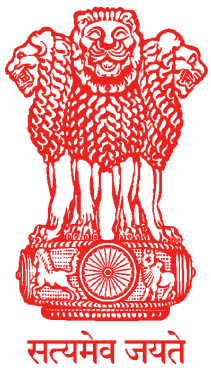
Technical Manual on Natural Farming



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References

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Introduction

Natural Farming (NF) is understood as a chemical free farming practice involving livestock integrated natural farming methods and diversified crop systems rooted in the Indian traditional knowledge. NF follows local agro-ecological principles rooted in local knowledge, location specific technologies and is evolved as per the local agro-ecology. Increased cropping intensity through multiple cropping systems, increased soil organic matter and soil fertility, increased dietary diversity to farmers, reduced cost of production, etc. are some of the benefits of natural farming.

Understanding of NF is based on the traditional agriculture systems that are prevalent across the country. Practices such as use of natural inputs, mulching, green cover etc increases the soil organic biomass & water infiltration, improves soil structure and contributes to the nutrient cycle and soil composition. Multi-cropping systems and water management practices involving models such as mulching, trap crop, border crops, rainwater harvesting grid blocks, trenches, ponds, etc. support diverse soil microbiomes thereby suppressing soil-borne diseases, improving soil nutrient cycling, with higher soil water moisture holding capacity and better soil health. Growing a variety of crops creates habitats for a wide range of organisms, including beneficial insects, birds, and other wildlife providing ecosystem services such as pollination, natural pest control, maintenance of natural food cycle (predator-prey relationships which reduces the likelihood of pest outbreaks), suppresses weeds through varied crop canopies and planting schedules, etc.

A planned transition towards a mass movement (Jan Bhagidari) for natural farming needs to be scientifically backed up and requires dedicated long term investment by the scientific research and extension systems. The technical manual on Natural Farming will aid the process of transferring of the understanding of Natural Farming thus moving towards sustainability, climate resilience and safe food with scientifically backed Natural Farming approaches.

Natural Farming is best learnt through practice and experimentation. This Technical Manual on Natural Farming is a curation of the understanding of natural farming learnt from various farmers, communities, Agricultural Universities, ICAR Institutions and other Institutions with experience of research and extension in Natural Farming. This technical manual offers basic understanding on the principles of Natural Farming and its practices.

Principles of Natural Farming

Natural Farming recognizes the natural interdependence of soil, microbiome, plants, animals, climate and human agricultural requirements. Natural farming is location specific and follows the agro-ecological principles and is rooted in the local knowledge. Practice of natural farming, hence varies from region to region, however in line with the design of the natural ecosystem, all the natural farming practices follow principles that are given below :

1. Increased organic matter in the soil
2. Minimum soil disturbance
3. Diversified cropping systems
4. Round-the-Year Soil Cover (365 Days Soil Cover)
5. Integration of livestock
6. Pest management through Natural farming methods
7. No synthetic chemical inputs
8. Use of On-farm made natural farming bio-inputs
9. Use of locally adapted seeds

Through the above principles/practices, natural farming addresses 10 globally agreed agro-ecological strategies such as 1) Enhanced soil organic matter, 2) Diversified field borders, 3) Reduced tillage, 4) Water harvesting, 5) Livestock integration, 6) Cover & legume crops, 7) Poly cultures, 8) Agroforestry, 9) Habitat beneficial insects and 10) Active soil biology.

1. Increased Organic Matter in Soil

Soil organic matter is essential for maintaining a healthy nutrient cycle, soil fertility, and soil structure thereby revitalizing soil health, enabling long term sustainability of crop production, and enhancing soil resilience. Organic matter in soil comprises living organisms (microbes, earthworms, etc.), plant and animal residues, and decomposed materials. Soil with increased quantities of organic matter provides a favourable environment for higher microbial activity in soil which ensures increased secretions such as micro aggregates that support binding soil particles to improve soil structure. Improved soil structure increases water infiltration and water holding capacity of the soil. The secretions from the microbiomes release nutrients that contribute to the nutrient cycle and soil fertility.

1.1 Benefits of increasing Organic Matter in Soil

I. **Restore Essential Nutrients :** Organic matter acts as a slow-release reservoir for essential nutrients, including macro (nitrogen, phosphorus, potassium) and micronutrients (zinc, iron etc). The process of slow release supports consistent

nutrient availability, especially in heavily deteriorated soils. For example, in the rice-wheat belt, adding green manures like dhaincha and multivariate cropping during summer/fallow period helps in restoring soil fertility as well as reducing soil borne pathogens.

II. **Enhances Soil Biological Activity:** Beneficial microbes such as bacteria and fungi decompose organic materials, releasing nutrients and improving soil fertility. Organic matter in soil acts as the feed for these beneficial microbes. For example, in areas with black cotton soils, adding organic residues like cotton stalks and leguminous residues boosts microbial activity, enhancing nutrient cycling and reducing soil-borne diseases. It also encourages earthworm activity, which improves soil structure by aerating it and aides in further incorporation of organic matter.

III. **Improves Soil Structure and Water Retention:** Organic matter helps to bind soil particles into stable aggregates which improves soil structure, aeration, and root penetration. For example, adding compost in sandy soils enhances soil aggregation, reduces soil erosion and improves water infiltration. Soil aggregation also increases soil's water-holding capacity, increasing resilience in drought-prone areas. In rainfed regions, using green manure and crop residues significantly improves soil moisture retention.

IV. **Enhances Crop Productivity and Resilience :** Increased organic matter improves the plants capacity for nutrient uptake, supporting better growth and higher yields. Natural farming advocates intercropping, border cropping, bund cropping, trap cropping as mandatory practice which can result in crop diversification for improving soil organic matter and also enhance biological nitrogen fixation Organic matter also helps to prevent physiological disorders in plants caused by nutrient deficiencies.

V. **Sustainable Soil Fertility Management:** Adding organic matter to the soil reduces the need for synthetic chemical inputs, thus lowering input costs and minimizing environmental impact. Additionally, soils rich in organic matter sequesters carbon, contributing to climate change mitigation. For example in groundnut fields, composted crop residues help in maintaining soil fertility sustainably. Practices like mulching and cover cropping not only improves soil health but also helps to store carbon in the soil.

1.2 Some practices that Increase Organic Matter in Soil

I. **Application of Concoctions and on farm inputs :** Continuous application of concoctions such as ghan-jeevamrut and jeevamrut or on farm inputs are expected to decompose the below ground root and above ground canopy residues and improve the organic matter content in soil.

II. **Live mulching :** Planting leguminous cover / inter crops fix biological nitrogen, improve soil fertility, and help in controlling weeds and conserving water . These leguminous cover crops also provide a habitat for beneficial insects, thus enhancing biodiversity. Leguminous cover crops such as spreading type cowpea, horse gram, Calopogonium sp., etc., are also used as live mulch under natural farming and contribute to biological nitrogen fixation.

III. **Agroforestry Practices** : Agroforestry systems, where crops are grown alongside trees, naturally add organic matter through leaf litter and root biomass, enhancing soil health and promoting biodiversity.

IV. **Reduced tillage**: Reduced tillage (minimum and zero tillage) also contributes to improved organic matter. Reduced tillage and crop residue mulching are interdependent as crop residue mulch cannot be maintained when the soil is tilled.

2. Minimum soil disturbance

Minimum disturbance to soil is one of the key principles in natural farming as it plays an essential role in preserving the soil structure, fertility and overall soil health. Practices such as minimum tillage reduces disturbance to soil, enhances soil aggregation, improves retention of organic matter in soil, supports favorable environment for beneficial soil organisms, and contributes to sustainable, and resilient farming systems.

2.1 Benefits of minimum soil disturbance

I. Soil Health and Fertility

A. Preserves Soil Structure : Minimum tillage maintains the natural aggregation of soil particles, which is supported by soil organisms like earthworms, fungi, bacteria etc. These organisms create channels for water infiltration and root growth, improving the overall structure and health of the soil.

B. Enhances Organic Matter : Retaining crop residues (e.g., stalks of Maize and Redgram) on the surface allows them to decompose slowly, adding organic matter that feeds soil microbes and improves nutrient cycling. This organic matter acts as a sponge, enhancing moisture retention and soil fertility.

C. Reduces Soil Erosion : Crop residues left on the surface serve as a protective cover, reducing the risk of soil erosion caused by wind and

water. This is especially important in regions with high potential for soil erosion.

D. Improves Water Infiltration : The decaying roots from previous crops help direct water into the soil, reducing runoff and enhancing water absorption, which is particularly valuable in rainfed farming systems.
E. Supports Beneficial Organisms : By avoiding deep plowing, minimum tillage preserves the habitat for essential soil organisms, such as earthworms and mycorrhizal fungi, that enhance nutrient cycling, aerate the soil, and improve root health.
F. Enhances Mycorrhizal Networks : Fungi which form symbiotic relationships with plant roots, help crops absorb water and nutrients more efficiently. Minimum tillage protects and enhances the mycorrhizal networks, boosting crop resilience.
G. Carbon Sequestration : Minimum tillage retains soil carbon, reducing greenhouse gas emissions and increasing organic carbon levels in the soil, thereby boosting soil fertility and helps mitigate climate change.

II. Economic and Operational Efficiency

A. Lower Costs : Minimum tillage reduces fuel, labor, and machinery costs. For example, using zero-till drills to directly sow seeds saves on fuel and labor, while conserving soil moisture.
B. Reduced Need for Chemicals : Healthier soils foster natural pest suppression and nutrient cycling, which reduces the need for synthetic fertilizers and pesticides, lowering operational costs and minimizing environmental impact.

III. Resilience to Climate Variability

A. Improved Moisture Retention: Minimum tillage systems conserve soil moisture, which is crucial for coping with drought conditions and extreme weather events.
B. Enhanced Crop Health: By maintaining organic matter and moisture, crops are better able to withstand temperature fluctuations and erratic rainfall, improving overall farm resilience to climate stress.

2.2 Few practices that enable minimum soil disturbance :

I. No-Till Farming

A. Practice : Seeds are directly sown into undisturbed soil using specialized seed drills.
B. Application : For example, direct seeding of wheat after paddy, sowing & trailing of cowpea, cucurbits after harvest okra and maize harvest minimizes moisture loss, while preserving soil structure.

II. **Strip Tillage**
    A. Practice: Tillage is restricted to narrow strips where seeds are planted, leaving the rest of the field undisturbed.
    B. Application: In maize cultivation, strip tillage allows for planting while retaining crop residues between rows, enhancing water infiltration and reducing soil erosion.

III. **Mulching-Based Systems**
    A. Practice : Crop residues or green mulch are used to cover the soil, minimizing the need for tillage.
    B. Application: Mulching in vegetable farming (e.g., tomatoes, brinjals) reduces weed growth, conserves soil moisture, and prevents erosion.

IV. **Cover Crops**
    A. Practice : Fast-growing crops like mustard or cowpea are planted during fallow periods to protect the soil and add organic matter.
    B. Application: Horse gram, spreading type cowpea, calopogonium, spreading ground nut etc as a cover crop adds organic matter to the soil and reduces erosion.

V. **Integration of Livestock**
    A. Practice: Livestock, such as goats and sheep, replace plowing by aerating the soil and depositing organic matter through controlled grazing.
    B. Application: Rotational grazing on harvested fields enhances soil fertility and helps control weeds, reducing the need for tillage and use of inputs such as weedicides.

VI. **Use of Minimal-Tillage Equipments**
    A. Practice: Tools like zero-till drills, strip tillers, and roller crimpers are used to sow seeds with minimal soil disturbance.
    B. Application: In rainfed regions, zero-till drills are used for seed sowing, preserving soil carbon and promoting moisture retention.

VII. **Implementing Minimum Tillage Practices**
    A. Planned Crop Rotations: Alternating between deep-rooted and shallow-rooted crops naturally aerate the soil and improve its structure.
    B. Incorporate Crop Residues: Leave previous crop residues on the field to enrich the soil with organic matter and reduce erosion risks.

VIII. **Use Suitable Machinery**: Minimal-tillage equipment like zero-till drills or strip tillers that suit the local crop and soil conditions.

IX. **Adopt Agroforestry:** Integrate trees and shrubs to provide natural cover, improve soil stability, and enhance biodiversity.

X. **Monitor Soil Health**: Regularly assess soil parameters like organic carbon, compaction, and microbial activity to optimize tillage practices and ensure long-term soil health.

3. Diversified cropping systems

Diversified cropping systems involve growing multiple types of crops within the same farm, either simultaneously (intercropping) or sequentially (crop rotation). Incorporating diversified cropping systems supports diverse soil microbiomes thereby suppressing soil-borne diseases, improving soil nutrient cycling, with higher soil water moisture holding capacity and better soil health. By integrating various crops, farmers can create a more sustainable, climate resilient, and productive farming system. Additionally, diversified crops enhance the nutritional and dietary diversity for the farmers' family.

3.1 Benefits of Diversified Cropping Systems :

I. **Enhances Soil Health**
   A. Soil Structure and Fertility: Different crops have varying root structures, which provide diverse organic matters to the soil. For example, legumes like green gram and field beans fix nitrogen, improving soil fertility and structure. Diverse root systems from crops like carrots and radishes help aerate the soil and prevent erosion.
   B. Microbial Health: Crop diversity supports a diverse microbial population, improving nutrient cycling and suppressing soil-borne diseases. For example, rotating legumes with cereals promotes soil biodiversity.

II. **Pest and Disease Management :** Growing a variety of crops creates habitats for a wide range of organisms, including beneficial insects, birds etc providing ecosystem services such as pollination, natural pest control, maintenance of natural food cycle (predator-prey relationships which reduces the likelihood of pest outbreaks), suppresses weeds through varied crop canopies and planting schedules, etc. For example, intercropping beans with maize can attract beneficial insects such as lady bugs which prey on aphids that target maize crops. Growing a range of crops reduces the likelihood of pests and diseases impacting the entire farm.

III. **Improved Water Use Efficiency :** Mixed cropping systems provide canopy cover that reduces soil evaporation, conserving moisture for longer periods. For example, groundnut and millet intercropping enhances water retention. Different root depths from crops like millets and legumes increase water infiltration and reduce runoff by breaking soil crusts and improving water absorption.

IV. **Weed Management :** Farm with diversified crop canopy provides shade to the soil, reducing weed growth. For example, intercropping groundnuts with sunflowers creates dense coverage, blocking sunlight and suppressing weed germination without relying on inputs such as herbicides.

V. **Climate Resilience :** Different crops have varying tolerance levels to drought, heat, water logging, flooding and other climate disasters, making diversified systems more resilient to extreme weather patterns. For example, mixing millets and legumes ensures better yields during drought conditions by utilizing deeper soil moisture with millet's deep roots and providing resilience with legumes' water-retaining properties.

3.2 Few more examples of diversified crop systems in India

I. Navadhanya & Akkadi Saalu (Andhra Pradesh & Karnataka): Groundnut, pigeon pea, sorghum, green gram, sesame, cowpea, castor, okra, amaranthus. Also, Pre Monsoon Dry Sowing (PMDS).
II. Hangadi Kheti (Rajasthan): Maize, black gram, pigeon pea, cotton, cowpea, groundnut, sesame, cucurbits, and vegetables.
III. Rammol (Gujarat): Pearl millet, sorghum, cluster beans, green gram, sesame, and castor.
IV. Kurwa (Jharkhand): Sorghum, maize, cowpea, rice bean, pigeon pea, millet varieties, velvet bean, and bottle gourd.

4. Round-the-Year Soil Cover (365 Days Soil Cover)

Round-the-year soil cover is a sustainable agricultural practice that ensures the continuous protection of soil through the use of living plants, crop residues, and mulch materials. This method mirrors natural ecosystems, where soil is never left exposed. By maintaining consistent cover, this practice promotes a stable environment for biological activity and nutrient cycling, benefiting soil health, water conservation, and overall agricultural productivity.

4.1 Benefits of Round-the-Year Soil Cover:

I. **Controls Soil Erosion:** Soil cover protects the topsoil from erosion caused by wind or water, preserving its structure and fertility. This contributes to long-term soil health and sustainability.

II. **Water Conservation:** Covered soil retains moisture better by reducing evaporation, ensuring consistent water availability, especially during dry spells. This reduces irrigation needs and enhances resilience to droughts.

III. **Microbial Habitat:** Soil cover supports a stable environment for beneficial microbes and earthworms, which aid in nutrient cycling and soil structure enhancement. This promotes healthier, more fertile soils over time.

IV. **Organic Matter Accumulation:** Organic residues decompose and enrich the soil, improving its capacity to store nutrients and water. This leads to improved soil fertility and long-term productivity.

V. **Weed Suppression:** Soil cover blocks sunlight, preventing weed growth and reducing competition for resources. This helps in reducing the need for inputs such as herbicides and promotes a natural and healthy local ecosystem.

VI. **Climate Regulation:** Soil cover helps in maintaining optimal soil temperature, reducing heat stress in summer and preventing damage from frost in winter. This creates a more stable growing environment for crops and beneficial organisms, enhancing resilience to extreme weather patterns.

VII. **Carbon Sequestration:** Plants and organic matter capture atmospheric carbon, helping mitigate climate change. This contributes to global efforts in reducing greenhouse gas concentrations.

VIII. **Economic Gains:** Use of soil cover crops reduces the need for external inputs such as fertilizers, herbicides, etc and irrigation, thus lowering production costs. Over time, this boosts farm profitability and sustainability.

IX. **Balances Local Ecosystem:** Promotes biodiversity by supporting pollinators, natural pest predators, and other beneficial organisms, creating a self-sustaining agricultural ecosystem that minimizes the need for interventions using chemical inputs.

4.2 Few practices followed to round-the-year soil cover :

I. **Crop residue management:** Retaining crop residues like husks or stubble. Example**:** In mixed cropping systems, crop residues are left on the soil to decompose, adding nutrients and preventing soil erosion.

II. **Diversified cropping systems:** Growing a variety of crops simultaneously with different root depths. Example**:** Combination of growing millets, red gram, and groundnut enriches soil, fixes nitrogen, and suppresses weeds.

III. **Agroforestry systems:** Integrating trees, shrubs, and grass crops. Example**:** Neem and Gliricidia trees act as windbreaks and improve soil fertility.

IV. **Cover crops:** Planting legumes like cowpea or sunhemp during fallow periods. Example**:** In dryland areas, sunn hemp protects soil, fixes nitrogen, and prevents erosion.

V. **Relay cropping:** Planting a secondary crop alongside a primary crop. Example: Mustard planted with maize ensures continuous soil cover and diversified income.

VI. **Grass strips and contour bunds:** Planting perennial grasses along contours. Example: Vetiver grass is used in hilly areas to prevent soil erosion and water runoff.

VII. **Perennial pastures:** Establishing permanent grasslands for grazing. Example: Napier grass provides both livestock feed and improved soil organic carbon.

VIII. **No-Till farming with cover crops:** Avoiding plowing while growing cover crops like clover or rye. Example**:** In semi-arid regions clover is used as a winter cover crop, which conserves water and reduces soil disturbance.

5. Integration of Livestock

Integrating livestock into farming systems is a key component of Natural Farming that enhances soil fertility, optimizes resource use, and diversifies income. Livestock, such as cattle, goats, sheep, poultry, fish etc. contribute to nutrient cycling, improve biodiversity, and provide a buffer against economic and climatic uncertainties, all while reducing dependency on externally purchased inputs.

5.1 Benefits of integrating livestock :

I. **Nutrient Cycling and Soil Fertility :** Livestock manure is rich in essential nutrients like nitrogen, phosphorus, potassium, and organic carbon, which enhance soil health. Livestock manure enhances soil organic matter, microbial activity, and water retention. Manure, including animal urine, improves soil microbial activity and provides a natural fertilizer for crops, reducing the need for inputs such as fertilisers.

II. **Biodiversity and Ecosystem Services :** Livestock grazing helps manage vegetation, control weeds, and create habitats for pollinators and natural pest predators. For example, ducks and poultry contribute to pest control by feeding on insects and weeds, while grazing animals distribute manure across fields, enriching the soil. For example poultry in orchards helps control pests like fruit flies and provides nutrient-rich manure for trees.

III. **Efficient Resource Utilization :** Livestock can recycle crop residues, farm waste, and kitchen waste into feed, reducing waste and feed costs. Integrated fish farming in ponds also enhances nutrient cycling and boosts productivity.

IV. **Economic and Climate Resilience :** Livestock provides a consistent source of income through dairy, meat, eggs, or fish, acting as an economic buffer against crop failures. Their presence improves economic stability. Grazing livestock helps maintain soil cover, preventing erosion and enhancing drought resilience. Livestock can also act as “banks on hooves,” offering a liquid asset during emergencies.

5.2 Few practices that integrate livestock with farming :

I. **Mixed Farming**: Indigenous cattle breeds like Gir or Sahiwal produce milk and manure, while goats graze on fallow land to prevent weed growth. **Goat Rearing**

in Drylands: Hardy goat breeds like Jamunapari graze in arid regions and converts coarse vegetation into valuable manure.

II. **Poultry in Vegetable Fields**: Free-ranging chickens help reduce pests and fertilize soil with their droppings.

6. Pest and Disease Management Through Natural Farming Methods

Natural pest and disease management practices harness the ecological principles such as biodiversity, food web, resilience, natural pest suppression, etc. to control pest populations and disease incidence in a sustainable way, without relying on usage of inputs such as pesticides, insecticides etc. A natural farming farm invites a wide range of organisms, including beneficial insects, birds etc providing ecosystem services such as pollination, natural pest control, maintenance of natural food cycle (predator-prey relationships which reduces the likelihood of pest outbreaks). By fostering environmental balance, promoting biodiversity, and ensuring long-term soil health, it aligns with the principles of sustainable agriculture and Natural Farming.

6.1 Benefits of Carrying out Pest and Disease Management through Natural Farming

I. **Increased Biodiversity** : Natural pest management fosters biodiversity, encouraging the presence of beneficial insects, birds etc. that naturally regulate pest populations. Natural predators and a diverse ecosystem help control pest populations without disrupting the food chain or ecological harmony, leading to fewer pest outbreaks.

II. **Improved Soil Health** : Natural pest management supports a healthy microbial ecosystem that enhances soil fertility and structure.

III. **Cost-Effectiveness** : Utilizing locally available resources like neem, cow urine, and botanical extracts significantly reduces costs incurred for purchasing compared to synthetic pesticides.

IV. **Residue-Free Produce** : Crops grown with natural pest control methods are free from pesticide and insecticide residues, appealing to consumers who prioritize safe and residue free food.

V. **Sustainability and Climate Resilience** : Natural pest management creates farming systems that are more adaptable to changing climatic conditions, helping ensure consistent yields even under stress.

6.2 Few examples of practices followed for natural pest and disease management

I. **Prophylactic Methods :**
   A. Field Sanitation: Regularly remove weeds and infected crop residues to reduce pest breeding grounds.
   B. Seed Treatment: Coat seeds with natural substances such as cow urine or ash to protect them from soil-borne pests.

II. **Cultural Methods :**
   A. Crop Rotation: Rotate crops to disrupt pest life cycles. For example, rotating cereals with legumes helps break the pest cycle while improving soil health.
   B. Intercropping: Grow pest-repellent plants alongside crops to naturally deter pests. Plants like marigold or garlic can be intercropped with vegetables to reduce infestations.
   C. Trap Crops: Plant trap crops such as marigold or castor near the main crop. These attract pests, keeping them away from valuable crops, and help monitor pest populations.

III. **Adjusting Planting Schedules:** Timely sowing and harvesting to avoid peak pest seasons can reduce pest damage. For example, planting early-season crops can help avoid pest infestations during their peak breeding season.

IV. **Biological Methods :**
   A. Habitat for Beneficial Insects: Creates environments that attract natural predators such as ladybugs, spiders, and predatory wasps. For example, planting flowering hedgerows around fields can help support these beneficial insects.
   B. Botanical Extracts: Regularly spraying botanical extracts on crops can help manage pest populations. These natural solutions are effective and safe for both plants and the environment. For example,
      1. Neemastra: A mixture of neem leaves, cow dung, and cow urine, effective against sucking pests and caterpillars.
      2. Neem Seed Kernel Extract: Used as a contact insecticide that disrupts pest growth cycles.
      3. Brahmastra: A blend of neem, custard apple, papaya, and guava leaves fermented with cow urine, used as a bio-pesticide.
      4. Agniastra: A chili-garlic extract that acts as a natural repellent.

5. Dashparni: A combination of 10 different pest-repellent plant leaves, which is fermented and sprayed for pest control.

7. No synthetic chemical inputs

Natural Farming emphasizes building soil organic matter, which improves soil structure, water retention, and overall fertility. The focus in Natural Farming is on promoting and maintaining the health of beneficial soil microbes. These microbes play a key role in nutrient cycling, breaking down organic material and making nutrients available to plants. By promoting a diverse microbial ecosystem, Natural Farming improves soil health and enhances farm resilience. This natural microbial activity reduces the need for externally purchased synthetic chemical inputs while ensuring nutrient availability and disease suppression.

Techniques such as mulching, cover cropping, and increasing soil organic matter help improve water retention, reduce evaporation, and enhance water infiltration, allowing crops to access water more effectively, especially during dry periods. These practices ensure reduction in the need for externally purchased chemical inputs such as fertilisers, pesticides, weedicides etc. Also, by enhancing soil health, the Natural Farming methods also contribute to mitigating climate change through better carbon sequestration, reduce erosion, and improve resilience to weather fluctuations. Additionally, by reducing dependence on external inputs, farmers save costs while supporting biodiversity, benefiting pollinators, and ensuring long-term ecological stability.

Reduction in the use of externally purchased synthetic chemical inputs such as fertilizers, pesticides, herbicides etc. hence becomes a key principle of Natural Farming. This approach plays a critical role in restoring soil health, reducing environmental pollution, and ensuring the production of safe, nutritious food. By shifting away from externally purchased chemical inputs, farming can become more sustainable, ecologically aligned and cost-effective.

7.1 Few practices that act as an alternative to the synthetic chemical inputs such as fertilizers, pesticides, herbicides, weedicides etc :

I. **Use of on farm made natural farming bio-inputs** such as Jeevamrut, a fermented bio-culture made from cow dung, cow urine, jaggery, gram flour, and soil, enhancing soil fertility naturally.

II. **Natural Pest Control:**
    A. **Biological Controls:** Maintaining habitats for natural predators like ladybugs or Trichogramma wasps to control pest populations.

B. **Neem-Based Sprays:** Neemastra and Neem extracts act as effective natural pest control agents.

III. **Soil Health Improvement:**
   A. **Crop Rotation:** Alternating legumes with cereals replenishes soil nutrients.
   B. **multicropping:** Growing multiple crops together reduces pest outbreaks and improves soil health.

IV. **Weed Management:**
   A. **Mulching:** Crop residues, straw, or biodegradable materials suppress weeds naturally.
   B. **Cover Crops:** Growing legumes or grasses between cropping seasons helps suppress weeds.

8. Use of On-farm made natural farming bio-inputs

On-farm made Natural Farming bio-inputs like Jeevamrut, Beejamrut, etc are derived from natural resources like plant and animal materials. They play a crucial role in promoting soil health, enhancing plant growth, and reducing reliance on externally purchased synthetic chemical inputs. These NF bio-inputs are rich in beneficial microbes, enzymes, and organic compounds, supporting nutrient cycling, pest management, and soil rejuvenation, making them vital for sustainable agricultural practices.

8.1 Benefits of using on-farm made natural farming bio-inputs :

I. **Soil Microbial Activity :** NF Bio-inputs like compost, jeevamrut, and bio-cultures stimulate soil microbial populations, promoting the decomposition of organic matter and enhancing nutrient mineralization. These microorganisms help in processes such as nitrogen fixation, phosphate solubilization, and potassium mobilization, ensuring better nutrient availability for crops.

II. **Improved Soil Health :** NF Bio-inputs like jeevamrut enhance soil structure, increase water-holding capacity, and promote nutrient availability. Beneficial microbes like Rhizobium (for nitrogen fixation) and mycorrhizal fungi (for nutrient uptake) thrive in soils treated with NF bio-inputs.

III. **Enhanced Pest and Disease Resistance :** NF bio-inputs like Neemastra, Jeevamrut, Saptadhanyankura solution, sour butter milk etc strengthen plant defenses, reducing pest and disease incidence. The beneficial microbes in NF bio-inputs boost natural immunity, making crops more resistant to infections.

IV. NF bio-inputs provide balanced nutrition, and help in reducing physiological disorders in plants that are caused by nutrient imbalance leading to better-quality crops.

V. **Environmental and Health Benefits :** NF bio-inputs minimize environmental risks, such as groundwater contamination, soil toxicity, and the harmful effects of chemical residues on human health. By using natural inputs, the farming system becomes healthier and more eco-friendly.

VI. **Resilience to Climate Stress** : NF bio-inputs improve soil organic matter, water retention, and root development, making crops more resilient to droughts, temperature fluctuations, and other climate-related stresses.

VII. **Sustainability and Circular Economy :** By utilizing farm waste (like crop residues, cow dung, and urine), NF bio-inputs turn potential waste into valuable resources, contributing to a circular economy that minimizes waste and maximizes resource use.

9. Use of Locally Adapted Seeds

Locally adapted seeds are varieties that have naturally evolved and thrived in specific ecological and climatic conditions over generations. These seeds, often farmer-saved or indigenous, are essential for sustainable farming as they preserve genetic diversity, improve resilience to local environmental stresses, and align with the principles of Natural Farming. They are typically better suited to low-input agricultural systems and contribute to the long-term sustainability of farming practices.

9.1 Benefits of using Locally Adapted Seeds :

I. Preservation of Agro-Biodiversity

A. Conservation of Genetic Resources: Locally adapted seeds embody centuries of farmer-led selection, preserving valuable genetic resources. These seeds contribute to agro-biodiversity, which supports ecosystem functions like nutrient cycling and pollination.

B. Reduction in Genetic Uniformity: Over-reliance on hybrid or commercial seeds reduces genetic diversity, which increases vulnerability to crop failures due to pests, diseases, or climate extremes. Local seeds maintain genetic variability, which enhances resilience.

II. Suitability for Low-Input Farming Systems

A. Minimal Dependency on External Inputs: Locally adapted seeds are well-suited for low-input farming systems, thriving without the need for externally purchased inputs like fertilizers, pesticides etc. For example, native finger millet varieties in Karnataka perform well in nutrient-poor soils, making them ideal for Natural Farming practices.
B. Cost-Effectiveness: Farmers who grow locally adapted varieties benefit from natural pest resistance, avoiding externally purchased chemical pest control treatments.

III. **Cultural and Nutritional Relevance**
   A. Nutritional Superiority: Many traditional varieties are richer in essential nutrients compared to hybrid varieties. For example, the indigenous rice variety 'Navara' from Kerala is celebrated for its medicinal and nutritional benefits.
   B. Preservation of Food Traditions: Local varieties are often aligned with regional culinary preferences and play an essential role in preserving cultural heritage and dietary diversity.

IV. **Resilience to Abiotic and Biotic Stresses** : Locally adapted varieties are naturally more resistant to drought and pests than hybrid varieties (FAO), making them more resilient to climate variability and pest outbreaks.

V. **Support for Agroecological Practices** : Intercropping systems, such as native millets and legumes in Andhra Pradesh, support biodiversity, conserve soil, and manage pests naturally.

Package of Practices for Natural Farming

1. Land Type and Soil type

The type of land plays a significant role in determining the most suitable cropping system and preparation techniques. Different soil types—such as loamy, clayey, or sandy—have distinct properties that affect water retention, drainage, nutrient availability, and root growth. Loamy soils, which are rich in organic matter, are ideal for most crops and require minimal amendments. Sandy soils, on the other hand, tend to drain quickly and may need additional organic matter to improve water retention and fertility. Clay soils, known for their ability to retain water, may require proper management of drainage to avoid waterlogging.

Understanding the land type helps decide on the best cropping practices, such as intercropping or rotating crops, which improve soil health. Land preparation in natural farming focuses on keeping the soil healthy by using organic materials like compost, mulch, or green manures to improve its structure. This way, the soil stays rich in nutrients and supports plant growth. By matching the right cropping system and land preparation to the land type, natural farming ensures better soil health, water management, and stronger crop growth.

2. Land Preparation

In Natural Farming, reduced tillage is scientifically important to preserve soil structure, promote healthy microbial ecosystems, and enhance long-term fertility. Minimal soil disturbance maintains the integrity of soil pores, facilitating water infiltration and root growth while preventing compaction. It also safeguards beneficial soil organisms, such as bacteria, fungi, and earthworms, which are vital for nutrient cycling. Excessive tillage can oxidize more than 95% of soil carbon from incorporated biomass, depleting carbon stocks and releasing CO2, which disrupts soil health and suffocates organisms. By avoiding deep tillage and adopting shallow tillage methods, microbial communities thrive, and the soil's natural ability to retain moisture and nutrients is enhanced, fostering a more sustainable and resilient agricultural system.

Land preparation in Natural Farming involves techniques that focus on preserving soil health and enhancing water retention. Bund preparation is commonly used to create raised formations along the field's boundary to control water flow and prevent erosion. Raised beds are another method, where beds are prepared to improve drainage, aeration, and facilitate better root

development. These methods are followed to maintain soil structure, reduce compaction, and promote effective water management.

- **Tillage and sowing:** Reduced / no tillage needs to be adopted in all the seasons. During summer, no tillage is preferred for raising multivariate crops like the Navadhanya system (Nine crops). Furthermore, the rapid deposition of incorporated biomass can lead to a swift release of nutrients when the main crop is not present to absorb them, resulting in nutrient leaching. Incorporating low-carbon legumes and high-carbon grasses, along with a variety of different species, further enhances soil health and improves system efficiency. Shallow tillage of 10-15 cm depth is preferred during kharif and rabi seasons. Deep tillage practices should be avoided. Sowing can be done by manual or mechanical methods. Shallow seed drills for sowing of crops are preferred.

3. Sowing methods

Sowing is done carefully to protect the soil and support healthy plant growth. Seeds are planted using manual or mechanical methods with minimal disturbance to the soil, keeping it intact and supporting soil microbes. Shallow seed drills and other traditional seed-sowing implements can be used to plant seeds at the right depth, ensuring better germination. This approach reduces the need for extra inputs and helps to maintain a healthy, sustainable farming system.

Transplantation is used for crops like paddy and certain vegetables to ensure healthy plant growth and efficient use of resources. Seedlings are carefully transplanted with minimal disturbance to the soil and roots, allowing them to establish quickly and grow robustly. The practice supports optimal spacing, which improves air circulation, sunlight exposure, and nutrient uptake. By maintaining the soil's natural structure and microbial activity during transplantation, the method aligns with sustainable farming principles, reducing the need for chemical inputs and enhancing long-term soil health.

4. Selection of Crops and Varieties

The choice of crops and varieties in Natural Farming is based on improving soil health, controlling pests naturally, and supporting biodiversity. Growing a mix of crops, like legumes and cereals, helps improve soil fertility by adding organic matter and fixing nitrogen. Traditional varieties suit local conditions and work well with natural processes, while tested improved varieties can also be used. Trap crops like marigold and okra help manage pests without chemicals. Genetically

modified (GM) seeds are not used in Natural Farming to protect the natural balance and follow its principles.

Natural farming promotes crop diversity having multiple crops grown simultaneously and strictly avoids Monocropping. Combination of cereals, legumes, fruits, vegetables along with trap/indicator crops such as marigold, okra, sunflower etc on bunds are preferred choice. Proven multi cropping methods recommended for the region can be adopted. Generally indigenous/traditional varieties are preferred as they perform better in Natural Farming systems. Certain improved varieties that are compatible with Natural Farming protocols can be recommended.

5. Seed treatment

Seed treatment is a crucial practice in Natural Farming as it enhances seed health, protects against diseases, and promotes strong seedling growth. It not only ensures healthier seedlings and faster germination but also supports the development of a robust root system, which enhances nutrient and water absorption. Additionally, the microbial cultures which are used for seed treatment strengthen the plant's immune system and boost nutrient uptake, helping the plants grow more efficiently. By enriching the soil's microbial community, seed treatment improves soil fertility, structure, and moisture retention, creating a healthier environment for crops. This practice leads to improved crop performance, increased resilience, and greater overall yield, all while maintaining the ecological balance of the farming system. Different methods of seed treatment are :

I. **Beejamrut (Beejamrutha or Bheejamrutham)** Seed dressing involves coating seeds with Beejamrut before sowing and drying them in the shade. This helps in protecting seeds and young seedling roots from soil-borne and seed-borne pathogens, reduce germination time, and enhance seedling vigor, leading to better growth. The application of beneficial microbes to seeds effectively places microbial inocula in the soil, positioning them to colonize seedling roots and protect them against soil-borne diseases and pests. Microbes improve seed germination, shoot and root length, seedling vigor, and crop performance. Beejamrut promotes root dry weight and root proliferation, enhancing nitrogen, nutrient, and water uptake by crop plants.

II. **Neem-based Solutions:** Soak seeds in a diluted solution of neem extract (Neemastram) or use neem seed cake for treatment.

III. **Ash Treatment:** Dust seeds with wood ash before sowing to prevent fungal infections and protect against pests.

6. Soil health management practices

Soil health is crucial in Natural Farming because it directly affects plant growth and the overall health of the farming system. Healthy soil is rich in organic matter, microbes, and good structure, all of which help plants grow strong. Organic matter acts as a natural fertilizer, providing nutrients to plants over time and improving soil structure. It also helps the soil hold water, which is essential for crop growth. When organic matter decomposes, it feeds beneficial microbes like bacteria, fungi, and earthworms, which help break down nutrients and protect against diseases. Using bio-inputs like jeevamrut and compost helps further improve soil health by adding good microbes to the soil. These microbes help make nutrients available to plants and improve soil structure.

I. **Residue recycling :** Residue recycling involves reusing crop residues such as stubble, leaves, roots, and other plant materials to enhance soil health. Instead of burning or discarding these residues, they are returned to the soil to improve soil structure, increase organic matter, and recycle nutrients. To apply residue recycling, collect plant residues after the harvest, including stubble and leaves. Shredding or chopping the residues into smaller pieces can accelerate decomposition. Incorporating the residues into the soil by plowing or tilling them at the end of the crop cycle ensures that they decompose and release nutrients back into the soil. Alternatively, residues can be composted with other organic materials like cow dung or kitchen waste. Mulching is another method, where plant residues are spread on the soil surface to protect the soil, conserve moisture, and reduce erosion. Residue recycling increases soil fertility by adding organic matter, improves soil structure by promoting root growth, reduces moisture evaporation, and helps prevent erosion.

II. **Cover crop :** Cover crops are plants grown to improve soil health, not for harvest. They are planted to protect the soil and enhance fertility during off-seasons or between main crops. To apply cover crops, choose appropriate species based on specific farm needs, such as legumes for nitrogen fixation or grasses for soil structure improvement. Cover crops are usually planted after the main crop harvest and can be seeded in the fall or during periods when the soil would otherwise be bare. After growth, they can be terminated by mowing, tilling, or leaving them as mulch. Cover crops improve soil fertility by fixing nitrogen, adding organic matter, and reducing soil erosion with their root systems. They

also suppress weeds by outcompeting them for sunlight and space and help conserve moisture in the soil, especially in drought-prone areas.

III. **Ghanajeevamrut :** ghan jeevamrut is solid in form and is prepared using ingredients such as desi cow dung (150 kg), jaggery (1 kg), pulse flour (2 kg), virgin fertile soil for microbial culture (50-100g), native/desi cow's urine as required.

IV. **Jeevamrut :** Jeevamrut is a liquid microbial inoculum, used to improve soil microbial activity and enhance soil structure. It is made by mixing cow dung, cow urine, jaggery, and pulse flour with water and allowing the mixture to ferment. It can be applied as a soil drench or foliar spray. Jeevamrut can be diluted with water before application. It enhances microbial growth, improves nutrient cycling in the soil, and supports root development in plants. This practice reduces the need for synthetic fertilizers and pesticides and contributes to the sustainability of the farming system.

7. Cropping system

A diversified cropping system is key in Natural Farming because it promotes biodiversity, improves soil health, and enhances overall farm resilience. Growing a variety of crops throughout the year ensures that the soil is continuously covered, which helps prevent erosion, retains moisture, and reduces weed growth. It also promotes better nutrient cycling, as different crops have varying nutrient needs and root structures, which improves soil fertility. By planting a mix of cereals, legumes, vegetables, and fruits, farmers can maintain a balanced ecosystem that supports beneficial insects, birds, and microbes, reducing the need for chemical interventions. Natural farming should be initiated / started preferably with legume crops.

I. **Poly/Multi cropping:** In this system, different crops play complementary roles that benefit the overall ecosystem and improve farm sustainability. Some crops act as trap crops, which are planted to attract pests away from main crops, thereby reducing pest pressure on the primary crops. For example, crops like marigold and sorghum can attract specific pests, preventing them from damaging valuable crops. Certain crops, like legumes, are important for nitrogen fixation. These crops, such as peas or beans, have a symbiotic relationship with nitrogen-fixing bacteria in their roots, which convert atmospheric nitrogen into a form that plants can use. This improves soil fertility and reduces the need for chemical fertilizers. Border crops and indicator plants like sunflowers or okra are used along field edges or in bunds. These plants can act as physical barriers,

preventing soil erosion, protecting crops from wind, and providing habitat for beneficial insects. Some plants serve as pest repellents due to their natural oils or strong scents, such as garlic or basil. These crops deter harmful insects and reduce the need for synthetic pesticides.

II. **Suggested cropping systems suitable for Natural farming based on ICAR Network research on Natural farming and studies made by SAUs**

A. **Chhattisgarh:** Soybean + maize-wheat + mustard
B. **Himachal Pradesh :** Tomato + French Bean + Brinjal, Cucumber + French Bean + Okra, Pea + Spinach + Coriander, Cabbage + Fenugreek + Coriander, Soybean + maize - vegetable pea + coriander (green leaf)
C. **Gujarat :** Wheat + Chickpea, Maize + Soybean, Wheat + Chickpea, Maize + Soybean, Wheat + gram, Wheat + Lucerne, groundnut + sesame, Pearl millet + Pulses, Castor + Green gram, Castor + Groundnut, Pigeon pea + groundnut, Turmeric + cowpea, Sorghum + Kalingda, Groundnut + Sesame-Fennel + Cabbage intercropping
D. **Karnataka :** Cotton + green gram – sorghum + chickpea, Cotton + Groundnut, Red gram + Groundnut, Red gram + Finger millet, Red gram+ Fox tail millet, Red gram+ Barnyard millet, Ground nut + Finger millet, Ground nut + Kodo millet, and Ground nut + Brown top millet, Finger millet-field bean, Paddy –soybean, Pigeon pea+finger millet , Finger millet – cowpea, Paddy – green gram, sugarcane + soybean, cotton + field bean etc.
E. **Kerala**: Cassava + vegetable cowpea-green gram, Turmeric + cowpea -greengram
F. **Madhya Pradesh**: Soybean + maize-wheat + mustard
G. **Meghalaya**: Turmeric + cowpea -greengram
H. **Rajasthan** : Groundnut + Sesame-, Fennel + Cabbage
I. **Sikkim**: Soybean + maize - vegetable pea + coriander (green leaf)
J. **Tamil Nadu**: Cotton + green gram– sorghum + chickpea
K. **Uttarakhand**: Soybean + maize - vegetable pea + coriander (green leaf)

III. **Pre-Monsoon Dry Seeding (PMDS) (rainfed areas)**: PMDS is a system of sowing, tilling and tending the land wherein the farmer grows crops in non-farming seasons or whenever there is no crop cover on the land. This can be practiced before the advent of monsoon, during summer, after Kharif and before beginning of Rabi season. PMDS, which involves sowing seeds just before the onset of the monsoon, is practiced to capitalize on existing soil moisture, enhance soil health, and boost yields by improving soil's physical properties.

Minimal or reduced tillage is typically applied in PMDS to preserve soil structure and maintain microbial activity. The PMDS involves raising of 8 to 15 diverse crops, as a mixed crop creates some special conditions for the seed germination through the beejamrut seed coating and plant survival during the dry seasons. The mulching material, which would be spread across the field, as a part of PMDS, acts as the catalyst to harness the water vapor from the atmosphere that drops to the land surface in the form of early morning dew. The mulching material facilitates the percolation of the dew into the soil and prevents its evaporation again. Therefore, PMDS needs to be practiced during March-May/ June, followed by Kharif crops, Pre-Rabi Dry Sowing (PRDS) and Rabi crops. The crops grown in PMDS and PRDS are used, ultimately, as green manure, after obtaining intermittently some cash income and food items and green fodder to animals. Seed pelletization is applied to PMDS (Pre-Monsoon Dry Sowing) seeds to offer several advantages, including improved seed protection, better germination rates, and ease of sowing. This process enhances the resilience of seeds in challenging conditions, ensuring better establishment during PMDS practices.

IV. **Multivariate cropping (irrigated areas)**: Multivariate crops like the Navadhanya system (Nine crops) are grown during the summer period In this approach, biomass is not incorporated into the soil but is instead fed to cattle. The emphasis is on using biomass for surface mulching or as fodder. While traditional green manure crops are intended for incorporation into the soil, this practice is discouraged in Natural Farming for several reasons. This should be practiced under no- till/reduced till to keep the soil covered, enhance the soil microbial activities through root exudates, and incorporate the biomass having varied C: N ratio to ensure a longer period of decomposition thereby extending the period of nutrient release. Crops of different duration and nature (cereals, pulses, oilseeds, fiber, green manures) are to be grown as mixed under multi- variate cropping. Typically, a minimum of 09 crop seeds are to be mixed and broadcasted during the summer or fallow period. About 25% of the seed rate of the sole crop is to be adopted for each crop. Before the main crop is sown or planted, the biomass from multivariate cropping needs to be incorporated into the soil after harvesting of economic produce if any from the system. The multivariate cropping helps to reduce soil-borne pathogens through annidation and allelopathy besides the other benefits.

8. Mulching

Mulching is important in natural farming because it helps maintain soil moisture, reduces water evaporation, and ensures consistent moisture availability to crops, especially during dry periods. The layer of mulch acts as a barrier that slows

down the loss of water from the soil surface, keeping the soil hydrated and reducing the need for frequent irrigation. This is particularly beneficial in regions with water scarcity or during hot weather.

Mulch also contributes to soil fertility by adding organic matter as it decomposes. This organic material improves soil structure, enhances nutrient availability, and supports the growth of beneficial microorganisms. It promotes better soil aeration and water infiltration, ensuring that the soil can retain nutrients and moisture more efficiently. In addition, mulch helps suppress weed growth by blocking sunlight, which reduces competition for resources and minimizes the need for chemical herbicides. Overall, mulching is a key practice that supports healthy soil, improves water retention, and promotes sustainable crop production.

Natural farming promotes many types of mulching including :

1. Soil mulching (tillage of the soil as minimal, to a reduced depth of 10-15 cm),
2. Straw mulching (spread dried crop residues or straw from the previous crop), and
3. Live mulching (raising diverse legume intercrops with cereals for supplying phosphorus, potassium, and sulphur to monocotyledons, such as rice, wheat, ragi, etc.).

Crop residue mulching should be applied immediately after sowing of the crops to reduce germination of weeds in the field. Depending upon the crop residues, generally 5 to 7 tonnes are required to cover one ha area for all the crops except rice in which Azolla can be used as mulching material. Mulching should be done in all the seasons. Some of the leguminous cover crops which can be introduced in natural farming are spreading type cowpea, horse gram and calopogonium.

9. Weed Management:

Weed management in natural farming is effectively achieved through diversified cropping systems like intercropping or multi-cropping, which reduce space and resources available for weeds. Fast-growing or dense-canopy crops help shade the soil, preventing weed seed germination. Maintaining rich, healthy soil with abundant organic matter supports vigorous crop growth that naturally outcompetes weeds. Organic matter, like crop residues or compost, acts as mulch, further preventing weed growth by blocking sunlight.

First weeding is done two weeks after seed sowing or after transplanting. For early weeding use weeder or cone-weeder or cycle weeder at every 15 days intervals for three times. It will reduce labour cost, allow soil for aeration, luxuriant root growth and easy access of soil nutrient and water.

10. Plant Protection:

Plant protection relies on creating a balanced ecosystem to manage pests and diseases. Diversified cropping systems, such as intercropping and polyculture, help disrupt pest life cycles by offering habitats for natural predators like ladybugs, birds, and spiders, which control pest populations and disease causing organisms. These systems also make it harder for pests to target multiple crops at once. Seed treatments strengthen seedlings, enhancing their resistance to pests and diseases. Trap crops, such as marigold or sunflower, attract pests away from main crops, reducing damage. For example, pests like the bollworm, which affects cotton, are controlled by rotating crops and intercropping with non-host plants such as mari gold, garlic etc., disrupting the pest's life cycle. By focusing on soil health, biodiversity, and natural pest management techniques, natural farming creates an environment where pests are kept in check, supporting healthier crops and ecosystems.

By maintaining healthy seeds, improving soil health, and using preventive cultural and biological methods, the need for external chemical control is reduced. Below is a detailed approach to pest and disease management that integrates natural practices across various stages of crop cultivation.

I. **Healthy Seed Selection:** Healthy, disease-free seeds are the foundation of successful pest and disease management. Seedborne diseases can be the primary source of pest outbreaks in a field. Using high-quality, locally adapted seeds reduces susceptibility to pests and diseases. Select disease-resistant, locally adapted seeds that are naturally suited to the region's environmental conditions. These seeds often have built-in resistance to local pests and diseases, which reduces the need for external chemical treatments.

   A. Seed or Seedling Treatment: Treating seeds and seedlings before planting helps prevent the spread of diseases and pests in the early stages of growth.

   B. Beejamrut : Soak seeds in a mixture of cow dung, cow urine, and soil (beejamrut) for 24–48 hours before planting. This treatment enhances

seed germination, protects against soil-borne pests and diseases, and promotes healthy root development.

C. **Neem-based Solutions**: Soak seeds in a diluted solution of neem extract (Neemastram) or use neem seed cake as a natural repellent.

D. **Ash Treatment**: Dust seeds with wood ash before sowing to prevent fungal infections and protect against pests.

II. **Prophylactic Methods:**

A. **Field Sanitation**: Remove infected plant residues and debris at the end of each crop cycle. For example, after harvesting vegetables like tomatoes, remove leftover stems and leaves that may harbor pests such as aphids or whiteflies. Burning or composting these residues helps prevent pest cycles from continuing.
B. **Monitoring and Early Detection**: Regularly inspect plants for early signs of pest or disease issues. If aphids are spotted on young tomato plants, an early intervention with neem oil or garlic spray can prevent a large infestation.
C. **Crop Rotation**: In a farm practicing crop rotation, after growing maize, a farmer might plant legumes like chickpeas or soybeans next season. This breaks the life cycle of pests specific to maize while improving soil nitrogen levels.

III. **Cultural Methods:**

A. **Weed Control**: By regularly weeding fields, farmers can remove unwanted plants that can serve as hosts for pests like beetles or aphids, which might otherwise target the main crops.
B. **Pest-Repellent Intercropping**: Planting marigold alongside vegetable crops like tomatoes or beans is an effective way to deter harmful pests like whiteflies, aphids, or nematodes. The strong scent of marigold naturally repels these pests.
C. **Nutrient Enhancing Intercropping**: Planting a nitrogen-fixing legume like groundnut or soybeans alongside cereals like maize or sorghum enhances soil fertility, provides natural pest resistance, and creates a more diverse ecosystem that benefits beneficial insects.
D. **Trap Crops**: For example, Planting mustard around the edges of vegetable fields can attract aphids and caterpillars, reducing the pest

pressure on the main crops like cabbage or cauliflower. Once the mustard plants attract the pests, they can be removed or destroyed, preventing them from infesting the main crop.

E. **Border Crops**: Planting Border Crops with Marigold or Garlic: Border crops such as marigold or garlic around vegetable fields act as natural pest barriers. Marigolds repel nematodes, aphids, and beetles, while garlic's strong odor deters a variety of pests, including aphids and flies. Barrier Cropping with Sorghum: In a field of groundnut or cotton, farmers can plant tall sorghum as a natural barrier crop. The dense foliage of sorghum acts as a windbreak and helps reduce the movement of airborne pests like moths or caterpillars into the main crop.

F. **Botanical concoctions for insect Management** : As such, natural farming promotes the use of various kashaya (decoctions) from locally sourced ingredients like cow urine, neem leaves, green chilies, garlic, tobacco, sour buttermilk, etc., to act as natural fungicides and pesticides. Some of the prominent ones used are Agniastra, Bramhastra, Neemastra and Dashparni ark. Prophylactic spray of these botanical concoctions every 15 days or in a month depending upon the crops are recommended under natural farming.
    1. **Agniastra** : This spray effectively controls pests like leaf roller, stem borer, fruit borer, and pod borer.
    2. **Brahmastra** : This effectively controls sucking pests, fruit borer, and pod borer.
    3. **Neemastra** : It is effective against sucking pests and leaf-eating caterpillars.
    4. **Dashparni ark:** Dashparni ark is used to control borers, maggots/ caterpillars. It should be used within 3 months.

G. **Botanical concoctions for disease management :**
    1. **Sonthastra**: It is used to control fungus.
    2. **Khatti lassi (Sour butter milk)**: This is used to control fungal diseases. Also found to be a virus killer.
    3. **Use of cow urine**: This is to control soil and seed borne diseases. It also controls seedling and wilt diseases in plants. It also protects the plant from bacterial and fungal diseases.

11. Harvesting Practices

Should be done manually or with minimal mechanical intervention to preserve soil health and structure. This approach helps avoid soil compaction, ensures that organic matter is left on the ground to decompose, and supports beneficial organisms in the soil. Manual harvesting also allows for selective harvesting,

ensuring that only mature crops are collected, which helps maintain the ecological balance of the farm. Additionally, it prevents the loss of valuable nutrients and ensures that crop residues remain on the field, promoting long-term soil fertility. By using low-impact harvesting methods, natural farming ensures that the land remains healthy and productive for future seasons.

I. **Timing of Harvest**: The timing of harvest plays a critical role in both the quality of the produce and the preservation of seed viability. It is important to harvest crops when they reach physiological maturity but before they over-ripen, which can lead to a decrease in quality or increased susceptibility to pests and diseases. For example, vegetables like tomatoes, harvest when they are fully ripe but firm.

II. **Weather Conditions**: Harvesting should be done during dry weather conditions to prevent the introduction of excess moisture into the harvested produce. This helps in reducing the chances of fungal infections or decay, which can affect both the harvested produce and the saved seeds. For example, avoid harvesting crops during rainy days to ensure seeds do not absorb moisture, which can reduce their storage life or cause mold growth.

III. **Manual Harvesting**: Use of Traditional Tools: In natural farming, tools like sickles, knives, or even hands are often used for harvesting. These tools allow for selective harvesting, reducing damage to the plants and the surrounding soil. Avoiding mechanical harvesters minimizes soil compaction and promotes biodiversity.

IV. **Gentle Handling**: When harvesting, care must be taken to avoid damaging the plants and the seeds. For example, when harvesting grains, cut the plants gently and bundle them carefully to avoid damaging the seed heads.

12. Post-Harvest Handling:

Post-harvest practices in natural farming focus on preserving the quality of crops while maintaining soil health and minimizing waste. After harvesting, crops should be handled carefully to avoid damage and loss of nutrients. Where possible, crop residues should be left in the field to decompose, adding organic matter and enhancing soil fertility. This can also be used for mulching in the next crop cycle.

I. **Cleaning**: Once the crops are harvested, they should be cleaned to remove soil, dirt, and plant residues. This helps to prevent the spread of pests and diseases to the stored seeds.

II. **Drying:** Seeds from crops like beans, grains, and tomatoes should be thoroughly dried to ensure long-term storage. Seeds should be spread out in a shaded, well-ventilated area to dry naturally, avoiding direct sunlight that may damage seed quality.

III. **Storage of Produce**: Proper storage of harvested produce is essential to maintain quality. If the produce is for consumption, it should be stored in cool, dry conditions to extend shelf life and avoid spoilage. If the goal is to store seeds, they must be placed in cool, dry, and airtight containers to avoid moisture absorption, which can lead to germination or spoilage. Glass jars, cloth bags, or paper envelopes are commonly used for seed storage.

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Annexure- I

Generic Protocols for Natural Farming

Natural Farming involves a set of holistic and comprehensive practices from tillage to selection of crops & varieties, raising of crops including management of on-farm inputs for realizing optimum productivity, economic advantage and improving soil health. The generic protocols for evaluation and demonstration of Natural Farming are described below.

1. **Selection of Crops and Varieties:** Natural farming promotes crop diversity having multiple crops grown simultaneously. Combination of cereals, legumes, fruits, vegetables along with trap/indicator crops such as marigold, okra, sunflower etc on bunds are preferred choice. Monocropping should be strictly avoided. Proven intercropping methods recommended for the region can be adopted. Generally indigenous/traditional varieties are preferred; however, improved varieties of crops can also be used under natural farming.

2. **Tillage and sowing:** Reduced / no tillage needs to be adopted in all the seasons. During summer, no tillage is preferred for raising green manures or multivariate crops. Shallow tillage of 10-15 cm depth is preferred during kharif and rabi seasons. Deep tillage practices should be avoided. Sowing can be done by manual or mechanical methods. Shallow seed drills for sowing of crops are preferred.

3. **Cropping during summer/fallow period**

    a. **Pre-Monsoon Dry Seeding (PMDS) (rainfed areas)**: PMDS is a system of sowing, tilling and tending the land wherein the farmer grows crops in non-farming seasons or whenever there is no crop cover on the land. This can be practiced before the advent of monsoon, during summer, after Kharif and before beginning of Rabi season. The PMDS involves raising of 8 to 15 diverse crops, as a mixed crop creates some special conditions for the seed germination through the beejamrut seed coating and plant survival during the dry seasons. The mulching material, which would be spread across the field, as a part of PMDS, acts as the catalyst to harness the water vapour from the atmosphere that drops to the land surface in the form of early morning dew. The mulching material facilitates the percolation of the dew into the soil and prevents its evaporation again. Therefore, PMDS needs to be practiced during March-May/ June, followed by Kharif crops, Pre-Rabi Dry Sowing (PRDS) and Rabi crops. The crops grown in PMDS and PRDS are used, ultimately, as green manure, after

obtaining intermittently some cash income and food items and green fodder to animals.

b. **Multivariate cropping (irrigated areas):** In general, the field is left fallow, or green manure crops such as Sesbania aculeata, Sesbania rostrata, sun hemp, etc., are grown during the summer period with conventional deep tillage operations. In natural farming, either green manuring crops such as Sesbania aculeata, Sesbania rostrata, sun hemp, moong or multivariate cropping during the fallow period in irrigated areas should be practiced under no-till/reduced till to keep the soil covered, enhance the soil microbial activities through root exudates, and incorporate the biomass having varied C:N ratio to ensure a longer period of decomposition thereby extending the period of nutrient release. Crops of different duration and nature (cereals, pulses, oilseeds, fibre, green manures) are to be grown as mixed under multivariate cropping. Typically, a minimum of 09 crop seeds are to be mixed and broadcasted during the summer or fallow period. About 25% of the seed rate of the sole crop is to be adopted for each crop. Before the main crop is sown or planted, the biomass from multivariate cropping needs to be incorporated into the soil after harvesting of economic produce if any from the system. The multivariate cropping helps to reduce soil-borne pathogens through annidation and allelopathy besides the other benefits.

4. **Poly/Inter cropping:** During the main seasons such as kharif, rabi and other seasons also poly or intercropping are advocated under natural farming. Proven intercropping practices can be adopted with recommended row ratios. Legumes are generally preferred as intercrops. Apart from this, trap crops such as marigold, okra, sorghum and indicator crops such as sunflower should also be grown in bunds and borders. Rice fields are not normally amenable to intercropping or mulching due to anaerobic conditions created through water inundation. In rice, under natural farming, practices such as intercropping of dhaincha, growing trap crops and legumes on bunds, and also mulching with Azolla should be adopted. Intercropping is practiced by simultaneously growing Azolla with rice and continuously harvesting as and when required, providing an additional source of income to the farmer. Sesbania aculeata and Sesbania rostrata can be intercropped in rice and incorporated after 30 to 35 days using cono weeders. Direct seeding machines for simultaneous sowing rice and green manures are available. Use of green manure as intercrops in rice helps for reducing the weed infestation and contributes for nitrogen fixation. Addition of green biomass also helps in improving soil organic matter.

5. **Concoctions (Beejamrut, Jeevamrut and Ghanjeevamut) for active soil biology :** Although many local and on-farm-based natural formulations or concoctions (mixtures) are used in chemical free farming approaches such as organic farming, Panchagavya farming, biodynamic farming, natueco farming, etc., the natural farming relies on on-farm prepared formulations or concoctions among which the important ones used are seed invigoration through beejamrut, reinvigorating the soil through jeevamrut and ghan jeevamrut . The preparation technique and detailed guidelines for the use of these formulations are described by Hari Om et al. (2024).

    a. **Beejamrut (Beejamrutha or Bheejamrutham)** is a microbial paste made using 5 kg of fresh dung from desi cows, 5 liters of desi cow urine, 50-100 g of virgin soil (preferably from forests, banyan trees, or termite mounds), 50 g of calcium chloride, and 20 liters of water. The mixture is thoroughly stirred and fermented for 24 hours. It is used for seed dressing or dipping seedling roots. Seed dressing involves coating seeds with beejamrut before sowing and drying them in the shade. beejamrut has been shown to protect seeds and young seedling roots from soil-borne and seed-borne pathogens, reduce germination time, and enhance seedling vigor, leading to better growth. The application of beneficial microbes to seeds effectively places microbial inocula in the soil, positioning them to colonize seedling roots and protect them against soil-borne diseases and pests. Microbes improve seed germination, shoot and root length, seedling vigor, and crop performance. beejamrut promotes root dry weight and root proliferation, enhancing nitrogen, nutrient, and water uptake by crop plants.

    b. **Ghan-Jeevamrut** : Ghan Jeevamrut is solid in form and is prepared using ingredients such as desi cow dung (150 kg), jaggery (1 kg), pulse flour (2 kg), virgin fertile soil for microbial culture (50-100g), native/desi cow's urine as required.
        i. **Method 1:** Mix well cow dung, jaggery, pulse flour and soil. Add a little bit of cow urine to it as needed. Dry the mixture in shade for 2-4 days. Use in the field after drying and grinding well into small aggregates. It can be stored and used for 6 months.
        ii. **Method 2:** Take 1-1.5 quintal well rotten desi cow dung manure and sprinkle 8-10 liters of jeevamrut on it. Mix well and use by broadcasting uniformly in the field. After preparing, keep it covered in the shade. It can be used for 6 months.
        iii. **Method 3:** Take 1.5 quintals of dry biogas slurry, a kilogram of jaggery, 2 kilograms of pulse flour and a handful of virgin soil. Mix

these well and broadcast uniformly in the field. Ghan jeevamrut can also be prepared by sprinkling jeevamrut solution on this slurry as per requirement. If ghan jeevamrut is prepared by adding jeevamrut solution, then there is no need to add jaggery, pulse flour and soil separately.

iv. **Method 4** (Best quality method): Make a pile of fresh cow dung partially dried up to 3-4 days up to a height of 1.5 feet. Size of the pile might be as per convenience (say 12x3 feet). Make holes with a wooden log at a distance of about 1 feet and fill up these holes with already prepared jeevamrut. Turn the dung pile up and down after one week. Then again make the holes and fill up these holes with jeevamrut and turn up the pile again after one week. This way this process is repeated 2-3 times. The Ghan jeevamrut will be ready in 30-35 days. Then after pounding it in small sized particles, it can be broadcasted uniformly in the field or stored in shade after covering with gunny bags.

- Generally, it is recommended to use 800 to 1000 kg per acre of land as a basal dose. However, this can be applied as top dressing also as per crop duration.

c. Jeevamrut (Jivamrita or jeevamruta or Jeevamrutha or Jeevamrutham) is a fermented microbial culture made from on-farm ingredients: 10 kg of fresh dung from desi cows, 10 liters of aged desi cow urine, 1.5 kg of cane jaggery (sugar) or sweet fruit pulp, and 1.5 kg of pulse flour mixed in a barrel with 180 liters of water. A handful (50-100 g) of virgin soil from banyan tree areas, forests, or termite mounds is added as a local microflora inoculant. The mixture is stirred daily and fermented for 48 hours in the shade. During fermentation, aerobic and anaerobic bacteria in cow dung and urine multiply as they decompose the organic ingredients. Cane jaggery enhances fermentation, and pulse flour provides protein energy. jeevamrut is ready after 3-4 days in summer and 6-7 days in winter and is applied to soil twice a month at a rate of 200 to 600 liters per acre depending upon crops and soil conditions, either through irrigation water or as a foliar spray. Application of jeevamrut or ghan jeevamrut through drip or sprinkler irrigation is preferred. jeevamrut acts as a catalyst, promoting soil microorganism activity, including earthworms, and making nutrients available to crops. Indigenous cow dung and urine produce the best jeevamrut due to higher beneficial microbial populations.

6. **Acchadana (Mulching of soil surface) :** Natural farming promotes many types of mulching including (i) Soil mulching (tillage of the soil as normal, but to a reduced depth of 10-15 cm), (ii) Straw mulching (spread dried crop residues or straw from the previous crop), and (iii) Live mulching (raising diverse legume intercrops with cereals for supplying phosphorus, potassium, and sulphur to monocotyledons, such as rice, wheat, ragi, etc.). Crop residue mulching should be applied immediately after sowing of the crops to reduce germination of weeds in the field. Depending upon the crop residues, generally 5 to 7 tonnes are required to cover one ha area for all the crops except rice in which Azolla should be used as mulching material under natural farming. Mulching should be done in all the seasons. Some of the leguminous cover crops which can be introduced in natural farming are spreading type cowpea, horse gram and calopogonium. Application of jeevamrut through drip/micro irrigation has an accelerating effect on multi/relay crops and polythene mulching may also be recommended depending upon the soil condition and requirement.

7. **Whapasa :** Whapasa refers to the soil condition where a balanced concentration of water and air molecules exists in the crop root zone. Natural farming promotes this state of soil condition with the application of minimal amount of irrigation, reduced tillage, and enhanced soil humus due to residue mulching and addition of concoctions. By maintaining Whapasa, water use by crops can be reduced significantly. Whapasa soil condition in the crop root zone under field conditions is feasible through application of jeevamrut using precision technologies such as micro irrigation systems such as drip and sprinkler irrigation including sensors, controllers, etc., to deliver a measured quantity of water with jeevamrut precisely in the vicinity of roots to achieve optimal soil-water-plant relations. Alternate furrow irrigation and surge irrigation can also be adopted. Flood irrigation should be avoided.

8. **Weeding :** Mandatory practices such as cover crops, intercropping, mulching with crop residues, polycropping etc significantly reduces the weed infestation naturally under natural farming. Time and quantity of mulching play a very important role in reducing the weed infestation. Generally dense mulching with crop residues immediately after sowing is preferred to manage the weeds effectively in the early stages of the crop. Non-Chemical weed management approaches such as hand weeding, shallow hoeing with tools, reduced spacing of crops, stale seed bed and other indigenous techniques can also be practiced as per need under natural farming.

9. **Botanical concoctions for insect Management :** As such, natural farming promotes the use of various kashaya (decoctions) from locally sourced ingredients like cow urine, neem leaves, green chilies, garlic, tobacco, sour buttermilk, etc., to act as natural fungicides and pesticides. Some of the prominent ones used are Agniastra, Bramhastra, Neemastra and Dashparni ark. Prophylactic spray of these botanical concoctions every 15 days or in a month depending upon the crops are recommended under natural farming.

    a. **Agniastra** is made by mixing 20 liters of cow urine with crushed tobacco powder (500 g), green chili (0.5 kg), garlic (0.25 kg), and neem leaves (5 kg). In a pot, add 20 liters of local cow urine, stir well, boil, cool, and ferment for 48 hours. After fermentation, filter the solution with cloth. Agniastra spray effectively controls pests like leaf roller, stem borer, fruit borer, and pod borer. Take 6-8 liters of filtered solution and dissolve it in 200 liters of water and spray it on one acre crop. It should be used within 3 months.

    b. **Brahmastra** uses 10 liters of desi cow urine and a paste of neem, Pongamia (karanj), custard apple, castor, and datura leaves (2 kg each). The manually crushed paste is boiled until frothing appears, filtered, and fermented for 48 hours in shade, stirred twice daily. Brahmastra is sprayed at 6–8 liters per 200 liters of water for one acre and effectively controls sucking pests, fruit borer, and pod borer. After preparation, it should be used within one month.

    c. **Neemastra** involves mixing 5 liters of desi cow urine, 1 kg of fresh cow dung, and 5 kg of neem leaf paste in 100 liters of water. Ferment the mixture for 48-96 hours, stirring twice daily, and filter with cloth. Neemastra is effective against sucking pests and leaf-eating caterpillars. Prepared material is sufficient for one acre.

    d. **Dasparni ark:** Dashparni ark preparation involves ingredients of water (200 liters), urine of native cow (20 liters), dung of native cow (2 kg), leaves of ten plants (Neem, Karanj, Castor, Sitaphal, Bael, Marigold, Tulsi, Dhatura, Mango, Aak etc.) 2.0 kg each, turmeric, asafoetida powder 500 g, ginger chutney 500g (heeng) powder 10 gm, dry ginger powder 200 gm, tobacco powder 1.0 kg, hot green chilli chutney 1.0 kg and desi garlic chutney 1.0 kg. Dissolve cow dung and cow urine well in water and keep it for 2 hours. Mix turmeric powder, ginger chutney and asafoetida powder well and keep it in the shade for 24 hours. Stir this mixture, mix dry ginger

powder, tobacco powder, hot green chillies and deshi garlic chutney well and keep it for 24 hours. Crush the leaves of plants and press them in this mixture. Cover the mixture with a gunny bag and keep it for 30-40 days and stir it for 2-3 minutes in the morning and evening. Mix 6-8 liters of extract of this solution in 200 liters of water and spray it on one acre crop. Dashparni ark is used for control of borers, maggots/ caterpillars.

10. Botanical concoctions for disease management

a. **Sonthastra:** Ingredients for using in one acre includes dry ginger 200 gm, desi cow's milk 5 liters and water 200 liters. Grind dry ginger and make powder. Mix it in 2 liters of water and boil it. Cool it when one liter is left. Boil 5 liters of indigenous cow's milk in a pot once. Cool the milk. Remove the cream of milk and use it domestically. Sieve the ginger water and boiled milk with the help of a cloth. After mixing in 200 liters of water, spray it on one acre crop. It is used for the control of fungus.

b. **Khatti lassi (Sour butter milk)**: Ingredients for one acre include water 100 liters, khatti lassi (3-5 days old) 5 liters, a small piece of copper, turmeric powder 50 gm. Keep the small piece of copper dipped for 3-5 days in khatti lassi Mix water and khatti lassi well and spray it on the crop after dissolving 50g turmeric powder in it. This is used to control fungal diseases. Also found to be virus killer.

c. **Use of cow urine:** Apply 30-40 liters of cow urine along with pre- sowing irrigation for controlling soil and seed borne diseases. It also controls seedling and wilt diseases in plants. The 10-20% spray of cow urine helps in controlling canopy diseases of crops. While planting fruit crops, apply 10% urine (one liter cow urine in 10 liter water) in the pits filled with the mixture of soil and cow dung manure/Ghan Jeevamrut before planting orchard seedlings. After planting, occasional application of 10-20% cow urine protects the plant from bacterial and fungal diseases.

d. **Saptdhanyankur ark:** It is basically advocated to increase the grain shine and weight. The ingredients include 100 gm seeds each of sesame (oilseed), moong, urad, cowpea, moth, gram (5 types of pulse seeds) and wheat. Soak sesame seeds in a little water overnight in a bowl. On the second day, mix sesame, moong, urad, cowpea, moth, wheat, gram seeds and soak them in water overnight. On the third day, after taking out all the seven types of seeds from the water, tie them in a bundle in a coarse

cotton cloth and hang them inside the house and keep the water safe. Then after the seeds have sprouted, grind all the seeds and make them like a sauce (chutney). Prepare a mixture of 200 liters of water, 10 liters of cow urine and safe water of seeds. In this, with the help of hands, mix the chutney of all the seven types of seeds and stir it with the help of a wooden stick. After the solution is ready, cover it with a gunny bag and keep it for two hours. After that filter it with a cloth. In this way Saptdhanyakur extract (ark) is ready for use. Specially use this extract within 48 hours. This is to be used during the milk stage of grains, infancy of the fruit (small beans) and bud stage in flower crops. Use of Saptdhayankur ark extract brings shine on the grains and reduces the dropping of flowers and fruits.

In addition to the above, depending upon the requirement, mechanical traps, pheromone traps, yellow sticky traps, bio-control agents such as Trichoderma, Pseudomonas, Trichogramma, Bacillus etc can also be used in the natural farming to manage insect and diseases in crops.

11. **Harvesting:** Sowing and harvesting can be done either manually or mechanically depending upon the crops and availability of machineries.

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Annexure- II

Recommended Packages under Natural farming by ICAR through Network research on natural farming along with AUs.

1. **Recommended states:** Gujarat and Rajasthan

    a. **Kharif season: Groundnut + Sesame**

Land preparation		Direct sowing (Sowing with minimum soil disturbance)
Seed treatment		Seed treatment with beejamrut
Sowing method		Ridge and furrow
Row ratio		6:2 (Replacement series)
Mulching material		Fennel straw (unchopped)
Mulching quantity (t/ha)		5 t/ha
Mulching time (days after sowing)		Immediately after sowing of crop (ground cover)
Weed management		Need based chemical free method of removing weeds
Basal	Source (Quantity)	ghan jeevamrut @ 1000 kg/ha
	Time of application	At the time of field preparation
Top dressing / foliar application	Source (Quantity)	jeevamrut @ 1500 lit/ha
	Time of application	jeevamrut @ 1500 lit/ha/Twice a month (with irrigation or spray on soil)
Time		Twice in a month
Source (Quantity)		Alternate application of Neemaster and Dashparni
Trap crop in borders		Marigold and tulsi

Disease	Management	
Crop	Groundnut	Sesame
Collor rot	Seed treatment with Trichoderma 6-8 g/kg seed Seed treatment with	-
Tikka disease	Foliar spray of neem oil @ 2 ml/L water	-
Powdery mildew		Spray of 2 % garlic paste

Phyllody disease		Spary of 10 % Dashparni
Insect-pest		
White grub, Termite and leaf minor	Application of Neem cake 5 q/ha at sowing, Pheromone trap @ 25/ha for mass trapping of adults, Metarhizium@5g/L water, Beauveria bessiana @5g/L water Spray of 10 % Dashparni	-
Hawk moth, aphid, semilooper		Azadirachtin 1500 ppm @ 5 ml/L water, Metarhizium@5g/L water, Bt @ 2ml/ L water and spray of 10 % Dashparni

b. Rabi season: Fennel + Cabbage

Land preparation		Direct sowing (Sowing with minimum soil disturbance)
Seed treatment		Seed treatment with beejamrut
Sowing method		Ridge and furrow
Row ratio		2:1 (Additive series)
Mulching material		Groundnut straw (Unchopped)
Mulching quantity (t/ha)		5 t/ha
Mulching time (days after sowing)		Immediately after sowing of crop (Ground cover)
Weed management		Need based chemical free methods
Basal	Source (Quantity)	+ ghan jeevamrut @ 1000 kg/ha
	Time of application	At the time of field preparation
Top dressing / foliar application	Source (Quantity)	jeevamrut @ 1500 lit/ha
	Time of application	jeevamrut @ 1500 lit/ha/Twice a month (with irrigation or spray on soil as per rainfall availability)
Time		Twice in a month
Source (Quantity)		Application of Neemaster/ Dashparni etc. (Alternate)
Trap crops in borders		Marigold and tulsi

Disease	**Management through organic sources**

Crop	Fennel	Cabbage
Powdery mildew	Spray of 2 % garlic paste	Spray of 2 % garlic paste
Insect-pest		
White grub, Termite and leaf minor	-	Pheromone trap @ 25/ha for mass trapping of adults, Beauveria bessiana @5g/L water, spray of 10 % Dashparni
Aphid	Azadiractin 1500 ppm @ 5 ml/ litre and spray of 10 % dashparni	-
DBM, aphid, tobacco caterpillar and semilooper	-	Pheromone trap @ 25/ha, Azadirachtin 1500 ppm @ 5 ml/ L water, SLNPV 250 LE/ha, Metarhizium@5g/L water, Bt @ 2ml/liter and Spray of 10 % dashparni

2. Recommended states: Chhattisgarh and Madhya Pradesh

a. Pre-kharif (Fallow period/summer)

Time/ week/ date	Crops/ seed to be mixed	Quantity (kg/ha)	Tillage operation	Method of sowing	Date/time/week of incorporation
2nd fortnight of April	Maize	7.5 kg	1-2 harrow, One rotavator, one tiller for mixing seeds	Broadcasting	2 weeks before sowing of next crop
	Sorghum	7.5 kg			
	Cowpea	6.25 kg			
	Sesame	1.75 kg			
	Sesbania	10 kg			
	Green gram	5 kg			

b. Kharif season: Soybean + Maize (4:2)

Land preparation	2-3 Harrowing, 1 planking
Seed treatment	Seed treatment with beejamrut
Sowing method	Drilled/line sowing
Row ratio	4:2 (Replacement series)
Mulching material	Unchopped Paddy straw / Wheat straw
Mulching quantity (t/ha)	6 t/ha

Mulching time (days after sowing)		Immediately after sowing of crop (ground cover)
Weed management		Need based weeding using chemical free methods
Basal	Source (Quantity on dry basis)	ghan jeevamrut @ 1000 kg/ha
	Time of application	At the time of field preparation
Top dressing / foliar application	Source (Quantity)	jeevamrut @ 1500 lit/ha
	Time of application	Twice in a month
Time		Twice in a month
Source (Quantity)		Alternate Application of Neemaster and Brahamastra
Trap crop in borders		Okra

c. Rabi season: Wheat + Mustard (8:2)

Land preparation		2 harrowing, 1 Planking, broad bed preparation
Seed treatment		Seed treatment with beejamrut
Sowing method		Drilling/Line sowing
Row ratio		8:2 (Replacement series)
Mulching material		Unchopped Paddy straw / Wheat straw
Mulching quantity (t/ha)		6 t/ha
Mulching time (days after sowing)		Immediately after sowing of crop (Ground cover)
Weed management		Need based weeding using chemical free methods
Basal	Source (Quantity on dry basis)	ghan jeevamrut @ 1000 kg/ha
	Time of application	At the time of field preparation
Top dressing / foliar application	Source (Quantity)	jeevamrut @ 1500 lit/ha
	Time of application	Twice in a month
Time		Twice in a month
Source (Quantity)		Alternate Application of Neemaster and Brahamastra

Trap crops in borders	Marigold

3. Recommended state: Kerala

Farmers' practices for natural farming of cassava and vegetables (based on geo-referenced survey of champion farmers (30 nos.) done during 2023-24 under AINPOF)

I. Casava Crop :

A. Treatment of cassava setts of 15-20 cm length in beejamrut prior to planting for 10 minutes and shade drying for 30 minutes. Sett treatment with Trichoderma asperllum mixed with beejamrut @ 5g/l prior to planting is also advisable.
B. Application of Ghan Jeevamrut @ 1 ton/ha at the time of plot preparation and planting
C. Application of jeevamrut @ 1500 litres/ha at fortnightly intervals till harvest as foliar or soil application
D. Crop residue mulching to ensure soil cover throughout the crop cycle
E. Intercropping with bush type vegetable cowpea in 1:1 ratio
F. Whapasa: Irrigation in alternate rows
G. Growing of short duration crops during fallow season (pulses, oilseeds, millets, vegetables, leafy vegetables)
H. Prophylactic/preventive method of application of Neemaster, Dashparni ark, Brahmaster, Neem seed kernel extract
I. Border crop, trap crop with marigold attracting natural enemies like spiders, green lacewing, dragon flies, damselflies, wasp
J. Curative application of leaf extracts of Datura, Vitex, Agniaster, sour butter milk, 2 G extract
K. Use of bio-control agents. Hymenopteran parasitoid, Acerophagus papayae against Paracoccus marginatus (Papaya mealybug) and hymenopteran parasitoid, Anagyrus lopezi against Phenacoccus manihoti (Cassava mealybug)
L. Use of mechanical traps. Yellow sticky traps @ 10-15 per ha to be used during the period of infestation against sucking pests, mainly whiteflies.

II. **Okra**

A. Most of the farmers follow bhindi in a cropping system
B. Selection of suitable variety is the most important problem faced by farmers because all varieties do not respond the same way to organic farming/natural farming

C. Seed treatment with beejamrut. Soak the seed overnight for easy germination
D. Basal application of vermicompost and Ghanajeeevamrit or cowdung enriched with Trichoderma (@ 1-2 t/ha) for early bearing
E. Application of P-solubilizing fungi-mycorrhizae-Vescicular Arbuscular Mycorrhizae (VAM) @ 3-5 g/seed beneath the seed before planting
F. Foliar application of jeevamrut (10%) or Panchagavya (3%) at 15-20 days interval
G. Application of fermented mixture of cowdung and ground nut cake at two leaf stage (@ 200-300 l/ha) and at an interval of 30-45 days after planting
H. Leaf roller and other pests are managed by neem oil, leaf extracts from neem and bird's eye chilli (kanthari) @ 1.5-2% in natural farming

III. **Amaranthus**

A. Intercropping of amaranthus with banana and cassava in their initial stages
B. Sowing the seeds after mixing with compost. Some of the farmers mix turmeric powder also along with the seed to avoid ant attack
C. Transplanting is done at 15-20 days intervals, mainly as intercrop with other crops such as cassava, banana or other vegetable crops or as sole crop in beds
D. Basal application of dried cow dung powder (@ 2 t/ha) or poultry manure (@ 1 t/ha) or Ghanajeevamrut (@1 t/ ha) before planting
E. Leaf spot is managed by using mix of supernatant of cowdung slurry, turmeric and soda powder (sodium bicarbonate) or Pseudomonas (10%) as foliar spray

IV. **Cucumber**

A. Application of organic manures viz., FYM (2-3 t/ha), poultry manure (1 t/ha), vermicompost, (1 t/ha), neem cake and liquid organic manures viz., jeevamrut (10%), Panchagavya (3%) and fish amino acid (1%)
B. Mulching with crop residue @ 2 t/ha
C. Pinching in cucumber to encourage lateral growth and get more yield
D. Manuring is done after pinching mostly neem cake @ 1 t/ha
E. Liquid manures are given at 45 days after planting @ 500 l/ha
F. Foliar application of Panchagavya (3%) followed by fish amino acid (10%) during productive stages results in better fruit quality
G. Pumpkin beetles are managed using neem oil, neem leaf extract or neem-based pesticides (1%) and fruit flies using traps

V. **Chilli**

A. Chilli is grown as rainfed crop and some of the farmers grow kanthari (Bird's eye chilli) under organic mode
B. Seed treatment with Trichoderma asperellum @ 4g/kg or Pseudomonas fluorescens 10g/kg or beejamrut
C. Basal application of compost or cowdung or poultry manure @ 2-3 t/ha before planting
D. jeevamrut (10%) or cow urine (10%) applied at 15-20 days intervals
E. Crop residue mulching @ 1-2 t/ha, with crops like Gliricidia
F. Sucking pests are managed by extracts of Dasagavya, neem leaf extract (1%), fish aminoacid (1%), neem oil-garlic emulsion etc.

VI. **Vegetable cowpea**

A. Cowpea can be grown throughout the year under Kerala condition
B. Vegetable cowpea mainly grown as sole crop as it requires trailing, but some bushy types are grown as intercrops in coconut and cassava
C. Seed treatment by dipping in Trichoderma asperellum @ 4g/kg or Pseudomonas fluorescens 10g/kg or beejamrut. Soak the seeds before planting for better germination
D. Basal application of cowdung or Ghanajeevamrut or poultry manure done before planting @ 1-2 t/ha
E. Trichoderma enriched cowdung for basal application @ 1-2 t/ ha
F. Application of jeevamrut (10%) or Panchagavya (3%) @ 15-20 days interval throughout the crop period
G. Pest management through neem oil or leaf extracts (1%)

VII. **Bittergourd**

A. Soak the seeds in beejamrut solution for 10-15 minutes and shade dry atleast 30 minutes before planting.
B. Basal application of vermicompost or dried cowdung before planting @ 2-3 t/ha
C. Application of fermented mixture of cowdung slurry and groundnut cake (200-300 l/ha) at 2 leaf stage and 30 days after planting
D. Pumpkin beetles are managed using neem oil, neem leaf extract or neem-based extracts (1%) and fruit flies using traps

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Annexure- III

Natural Farming Package of Practices by Sardarkrushinagar Dantiwada Agricultural University,
Sardarkrushinagar, Gujarat

1.	**Natural Farming practices:**
a.	**Soil health management practices:**
	i. Name of the Practices:
	Minimum tillage, Mulching, Inter-cropping, 365 days soil cover
	ii. Brief description of the practice:
	Minimum tillage Mulching or live soil mulch Inter-cropping / Mixed cropping Pre-monsoon dry sowing with different groups of crops
	iii. Benefits of the practices (impacts):
	Sustain and improve the soil organic carbon, Increase soil microbial population, Maintain soil temperature Improve WHC and sustain soil moisture Reduce weeds population
	iv. Protocols to be followed:
	Minimum tillage with indigenous implements or mini-tractor Mulching with available on farm crop residues Live mulch with green-manuring crops i.e. Sun hemp/pulses etc. Inter-cropping in cereals/oilseed crops with pulses [e.g. Wheat + gram (4:1), Wheat + Lucerne (mixed cropping), groundnut + sesame (4:2), Pearl millet + Pulses (1:1), Castor + Green gram (1:2), Castor + Groundnut (1:2), Pigeon pea + groundnut (1:2), Turmeric + cowpea (2:1), Sorghum+ Kalingda (6:1) etc.].
b.	**Nutrient management practices:**
	i. Name of the practices:
	Use of FYM, Ghanjivamrut, Jivamrut Intercropping
	ii. **Brief description of the practice:**

	Jivamrut and Ghan jivamrut are rich in nutrients like carbon, nitrogen, phosphorus, calcium etc. It boosts soil microorganisms, enhancing soil fertility and crop yield. It's made from cow dung and urine, promoting nutrient availability and microbial activity. This leads to an increasing earthworm population in soil. Soil microorganisms actively impact by cycling nutrients like carbon and nitrogen which is essential for plant growth.
	iii. **Benefits of the practices (impacts):**
	Sustain and improve the soil organic carbon, Addition and fulfil the nutrients requirement of different crops Increase soil microbial population, Improve WHC Improve soil structure
	iv. **Protocols to be followed:**
	2-4 t/ha FYM once in year during kharif season 2-4 t/ha Ghanjivamrut before sowing of the crops in each season Soil application of 1000-1500 l/ha Jivamrut at the time of sowing thereafter twice in month with irrigation. ✔ Foliar spray of 5-10 % of Jivamrut at 20 days after sowing jivamrut 2.5 litre/10 litre of water at 40 and 60 days after sowing.
c.	**Pest and Disease management practices:**
	i. **Name of the Practices:**
	Use of Neemastra, Bhramastra, Agniashtra, Dashparni Ark, Sunthastra, Jivamrut and Intercropping.
	ii. **Brief description of the practice:**
	To control the sucking and other pest
	iii. **Benefits of the practices (impacts):**
	To prevent the infestation of pest and disease
	iv. **Protocols to be followed:**
	Spraying of Neemastra @ 10 % (1000 ml /10 litre of water) at 45 DAS followed by Brahmastra @10% followed by Agnistra @10 % at 10 days interval of each spray. Erect 40 bird perches per hectare Install one light trap per hectare Sowing of yellow marigold flower in field as a trap crop.

	□ Soil application of Agniastra @ 200 litres/ha or Neem cake @ 1 tone /hectare before sowing. □ Drenching of 10 days decomposed liquid material (10 kg pieces of green cactus + 10 kg green leaves of milkweed (Calotropis procera) and 20 litre of 10 days old butter milk) @ 200 litre/ha after 20-25 DAS (ITK). □ Apply small pieces or paste of calotropis plant with irrigation or apply neem cake @ 1 tone /hectare before sowing and maintain soil moisture by irrigation to avoid attack on root zone for termite control. □ Spraying of prepared solution (10 days old butter milk dip with copper road or wire for 10 days) @ 5 % at 45 and 60 DAS for disease control.
d.	**Weed management practices:**
	i. Name of the Practices:
	□ Stale seedbed, □ Mulching, □ Intercropping
	ii. **Brief description of the practice:**
	Mulch and intercropping is a highly effective tool for weed control in natural farming systems. It works by blocking light, preventing seed germination, regulating moisture and temperature and even enhancing soil health. This reduces the need for manual weeding, creating a more sustainable and eco-friendly farming system.
	iii. **Benefits of the practices (impacts):**
	□ Suppress the weed population
	iv. **Protocols to be followed:**
	□ Allowing weed seeds to germinate and then killing them before sowing of crop □ Mulching with available on farm crop residues □ Live mulch with green-manuring crops i.e. Sun hemp/pulses etc. □ Inter-cropping in cereals/oilseed crops with pulses
e.	**Seed selection, treatment and sowing practices:**
	i. Name of the practices:
	□ Use of deshi & improved varieties □ Seed treatment with Beejamrut □ Drilling, Broadcasting & Dibling etc
	ii. **Brief description of the practice:**
	These traditional varieties are often better suited to the local environment, as they have evolved over generations to withstand local pests, diseases, climate and soil conditions. Bijamrut is an essential component of natural farming that promotes healthier crops. Bijamrut

	made from natural inputs like cow urine and cow dung, it improves seed germination, enhances plant growth and fosters a sustainable farming ecosystem.
	iii. **Benefits of the practices (impacts):**
	Low infestation of pests and diseases High nutritive value Good germination
	v. **Protocols to be followed:**
	Use of deshi & improved varieties [i.e. Bansi (wheat), local maize] Treat the seeds with 200 ml Bijamrut/kg of seeds before 8-10 hrs of sowing.
f.	**Cropping systems**
	i.Name of the practices: Intercropping, Mixed cropping
	ii. Brief description of the practice: Inter-cropping in cereals/oilseed crops with pulses, Wheat + Lucerne (mixed cropping)
	iii. Benefit of the practices: Intercrops helps to restore soil fertility when legumes are included as component crops. Suppress the weeds as well as reduce soil erosion, as the soil remains covered with plants.
	iv. Protocols to be followed: Inter-cropping in cereals/oilseed crops with pulses [e.g. Wheat + gram (4:1), Wheat + Lucerne (mixed cropping), groundnut + sesame (4:2), Pearl millet + Pulses (1:1), Castor + Green gram (1:2), Castor + Groundnut (1:2), Pigeon pea + groundnut (1:2), Turmeric + cowpea (2:1), Sorghum+ Kalingda (6:1) etc.].
g.	**<u>Water management practices</u>**
	i. Name of the practice: Micro irrigation/Check basin
	ii. Brief description of the practice: Due to shortage of irrigation water and loamy sand texture soil
	iii. Benefit of the practices: Saving of water Higher yield
	iv. Protocols to be followed: Mostly irrigation on the basis of CPE

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Annexure- IV

Junagadh Agricultural University
Junagadh, Gujarat

1. **Soil health management practices**

   a. **Name of the practice:**
      i. Cover Crops for Improved Soil Health
      ii. Reduced or zero tillage
      iii. Crop Rotation and Intercropping
      iv. Addition of organic sources of nutrients

   b. **Brief description of the practices**
      i. **Cover Crops for Improved Soil Health :** Cover crops are an essential and important part of soil fertility and health management in Natural farming. Cover crops are any crops that are cultivated together with or after the primary crop and are often removed prior to planting the subsequent crop. A cover crop can function as a green manure when it is ploughed under and incorporated into the soil while still green or at maturity.
      ii. **Reduced or zero tillage :** Reduced or zero tillage, also known as No-tillage, is a conservation tillage practice where seeds are directly sown into untilled soil without incorporating residues from previous crops.
      iii. **Crop Rotation and Intercropping :** Crop rotation and intercropping are two different types of cropping patterns followed on a farm to diversify crops and enhance cropping intensity
      iv. **Addition of organic sources of nutrients :** Organic sources of nutrients can be added to natural farming to improve soil condition, provide nutrients for crops, and minimize erosion.

   c. **Benefits of the practices (Impact)**
      i. Cover Crops for Improved Soil Health
         1. Provides ground cover and serve as green manure
         2. It increase plant residues retained on the soil surface, minimize soil disturbance and erosion, reduce the risk of erosion
         3. Enhances organic matter levels in soil returning their biomass
         4. Leguminous cover crops fix and enrich soil with nitrogen

5. Organic acids of their decomposition facilitates cycling and mineralization of nutrients in soil
6. Improve soil structure and water-stable aggregates
7. Cover crops with taproots can create macro-pores and alleviate soil compaction
8. Provide forage for livestock
9. Support pollinators and beneficial insects
10. Retain nitrate and other nutrients that are susceptible to leaching losses and hence reduce water and air pollution
11. Help to control various pests and weeds by acting as live mulch
12. Diverse cover crop maximize water and nutrient use efficiencies of crop production systems
13. Enhance net ecosystem productivity and longer-term carbon (C) sequestration

ii. Reduced or zero tillage

1. Soil undisturbed; reduced erosion, increases water infiltration
2. Retains crop residues on soil surface
3. minimizes soil moisture loss, preserves crop residue on the soil surface

iii. Crop Rotation and Intercropping

1. The capacity of pulses to fix atmospheric nitrogen within root system contributes to their self-reliant fulfilment of nitrogen requirements. Whereas the monocropping trends exhaust soil health and curtail yields.
2. Leguminous crops not only transfers nitrogen to non-leguminous plants, but also mobilizes organic P and insoluble P in soil by secreting phosphatases, or exudation of carboxylates or protons and also through mycorrhizal network

iv. Addition of organic sources of nutrients

1. These materials not only enrich the soil's nutrient content but also enhance its water-holding capacity and aggregate formation by adding organic matter.
2. The fostering of microbial activity contributes to nutrient cycling and soil organic matter decomposition

d. Protocols to be followed

i. Growing single or double species of plants as cover crops, the benefits to soil, crop and ecosystem is limited. Cover crops type Non Leguminous (Brassicas, rooted vegetables like beet root, radish, turnip etc and Leguminous (Cowpea, sun hemp, Sesbania, horse gram, Bengal gram, cluster bean, etc.) Mixed / multi species cover crops (In addition to all above crops, the crops like coriander, peas, bean etc)

ii. Excessive tillage causes soil compaction and related changes in soil physical-chemical properties viz., poor infiltration, poor soil structure, increased bulk density, reduced porosity etc. Hence adoption of non-inversion tillage is highly needed in natural farming.

iii. Crop rotation entails the sequential cultivation of two or more crops on the same plot within a farmland, aimed at optimizing nutrient management and ameliorating soil health.

iv. Application of cow based on farm preparations is an excellent source for sustaining soil health and nutrients cycling in natural farming. Wide range of concoctions recommended or in practice for NF are Jeevamrut, ghan jeevamrut etc. They have to be prepared on the farm itself.

2. Nutrient management practices

a. Name of the practice:

i. Application of jeevamrut

ii. Application of Ghan jeevamrut

b. Brief description of the Practice:

i. **jeevamrut and Ghan jeevamrut:** It is a formulation containing cow dung, cow urine, pulse flour and jaggery concoction used as soil application for enhancing the soil fertility.

c. Benefits of the practice:

i. jeevamrut is an organic fertilizer that is a vibrant source of nitrogen, phosphorus, potassium, and all other micronutrients that play a vital role in plant growth and development. It maintains the pH of the soil, improves the aeration in the soil, and increases the beneficial bacteria for plant growth.

ii. jeevamrut improves soil fertility by enriching it with essential nutrients and organic matter. The microorganisms present in jeevamrut break down complex organic compounds into simpler

forms, making them readily available to plants. This process enhances nutrient uptake, leading to healthier and more productive crops.

iii. The microorganisms in jeevamrut act as natural antagonists against harmful pests and diseases. They suppress the growth of pathogenic organisms by competing for resources and producing antimicrobial compounds. This natural defence mechanism reduces the reliance on chemical pesticides, making jeevamrut an eco-friendly alternative.

iv. jeevamrut promotes sustainable agriculture by reducing the dependence on synthetic fertilizers and pesticides. Its use minimizes the negative environmental impacts associated with chemical inputs, such as water pollution and soil degradation. Additionally, jeevamrut can be easily prepared using locally available materials, making it a cost-effective solution for resource-limited farmers.

d. Protocols to be followed

i. Preparation method of jeevamrut

1. For preparation of jeevamrut, we can use 200 liters of water, 10 kg fresh cow dung, 10 liters of Fresh cow urine, 2 kg gram flour, 2 kg jaggery and a handful of fertile soil.
2. Mix all these ingredients in a thoroughly clean large container and mix them well,
3. Cover them with the jute sack, or keep them in a shady place and stir them with the wooden stick in the barrel clockwise.
4. Keep repeating this process two times a day.
5. Let them ferment for 7 days.
6. After 7 days it is ready to use.

ii. Application of jeevamrut

1. **Soil application:** Application of 500 litres jeevamrut/acre with irrigation water twice in a month.
2. **Foliar application:** Foliar spray of 5-10% jeevamrut at 20-25 days interval 3 to 6 times depending upon the crop period.

iii. Preparation method of Ghan jeevamrut

1. Take 100 kg of well dried cow dung and spread it uniformly on ground in the form of a thin layer.

2. Sprinkle the already prepared jeevamrut (at the rate of 10% of dry cow dung) around 10 litre over the thin layer of 100 kg cow dung uniformly spread over the ground
3. Mix the sprinkled jeevamrut with dried cow dung with the help of spade.
4. Now, make a heap of treated cow dung and cover it using a jute bag and allow it to dry for 16 hours in the sunlight.
5. After drying is completed, make powder of the dried cow dung with the help of a thick wooden stick and store it in jute bags in the room.
6. Ghan jeevamrut can be stored for 6 months.

iv. Application of Ghan jeevamrut

1. Apply Ghan jeevamrut 2000 kg/ha before sowing of the crop

3. Pest and Disease management practices

a. Name of the practice:

i. Pest management

1. Application of Agniastra
2. Application of Brahmastra
3. Application of Dashparni Ark
4. Application of Neemastra

ii. Disease management

1. Application beejamrut
2. Application of sour butter milk
3. Application of dry ginger and cow milk solution (Suthastra)

b. Brief description of the practice:

i. Pest management

1. Agniastra: Agniastra effectively manages leaf rollers, stem borer, fruit borers and pod borers.
2. Brahmastra: Brahmastra effectively manages sucking pest and leaf eating caterpillars
3. Dashparni Ark: Dashaparni Ark effectively manages borers, maggots and caterpillars
4. Neemastra: Neemastra effectively manages sucking pest and leaf eating caterpillars

ii. Disease management

1. beejamrut: beejamrut effectively protects young roots from fungus and soil-borne and seed-borne diseases.

2. Sour butter milk: Sour Buttermilk effectively protects plants from air borne fungal pathogen.
3. Dry ginger and cow milk solution: Works against diseases. Spray 5% solution on infected parts of crop/ trees.

c. Benefits of the practice:

i. Pest management

1. Agniastra: Effectively control insect-pest population
2. Brahmastra: Effectively control insect-pest population
3. Dashparni Ark: Effectively control -pest population
4. Neemastra Effectively control insect-pest population

ii. Disease management

1. beejamrut: Controls all disease producing spores and causing seed borne diseases. Induce germination, terminates hibernation. uniform germination. keep healthy crop.
2. Sour butter milk: Kills all disease spores causing leaf diseases.
3. Dry ginger and cow milk solution: Protection against fungal and bacterial diseases causing foliar diseases in orchard or any field crops.

d. Protocols to be followed

i. Pest management

1. **Agniastra:**
    a. Mix 20 litre cow urine to a container. Then add crushed tobacco powder (500 g), green chilli (500 gram) and 250 grams garlic paste.
    b. In pot, add 20 litre of cow urine, stir well, boil, cool, fermented for 48 hours.
    c. After 48 hours, filter with a thin muslin cloth and store it.
    d. **Shelf life:** 03 months.
    e. **Dosage:** dissolve 6-8 litre of solution in to 200 litre of water and spray in one acre.
2. **Brahmastra:**
    a. Take 10 litre of desi cow urine in a vessel and a 2 kg paste of neem, karanj, guava, custard apple, castor, papaya and dhatura each. Then manually crushed

paste is boiled until frothing appears, filtered and fermented for 48 hours in shade, stirred twice daily.

b. **Shelf life:** 01 month
c. **Dosage:** dissolve 6-8 litre of solution in to 200 litre of water and spray in one acre.

3. **Dashparni Ark:**
    a. This requires ingredients of 200 litres of water in a drum, 20 litres of cow urine 2 kg of cow dung 2 kg of each ten plant (Neem, Karanj, Castor, Sitaphal, Bael, Marigold, Tulsi, Dhatura, Mango and Aak) leaves, turmeric, asafoetida powder 500 g, ginger chutney 500 g, Hing powder 10 g, dry ginger powder 200 g, 1 kg of tobacco powder, 1 kg of hot green chilli chutney and desi garlic chutney 1 kg.
    b. Dissolve cow dung and cow urine well in water and keep it for 2 hours.
    c. Mix turmeric powder, ginger chutney and asafoetida powder well and keep it shade for 24 hours.
    d. Stir this mixture, mix dry ginger powder ginger powder, tobacco powder, hot green chilies, and desi garlic chutney well and keep it for 24 hours.
    e. Crush the leaves of plants and press them in this mixture. Cover the mixture with a gunny bag and keep it for 30 to 40 days and stir it 2-3 minutes in the morning and evening.
    f. Keep away this mixture from direct sunlight and rain. This process takes 40 days to complete after that filter solution using a muslin cloth and store it in a pot. This can store up to 6 months.
    g. **Dosage:** dissolve 6-8 litre of solution into 200 litre of water and spray in one acre.
4. **Neemastra:**
    a. Mix 5 liters of desi cow urine, 1 kg of fresh cow dung and 5 kg of neem leaf paste in 100 liters of water.
    b. Ferment the mixture for 48-96 hours, stirring twice daily and filter with cloth.
    c. Dosage: Total prepared quantity is sufficient for one acre.

ii. Disease management

1. **beejamrut:**

a. Take 20 litres water, 5 kg desi cow dung, 5 liters desi cow urine, 50 g edible calcium, - 200 gram bund soil in a plastic drum/ mud pot/ iron drum/ cement drum.
b. Mix all the ingredients by stirring it with a wooden stick in a clockwise direction.
c. Soak the solution overnight.
d. Next day morning filter it with a nylon cloth and it can be used for seed treatment
e. **Shelf Life:** 48 hours.

2. **Sour butter milk:**
    a. Take 6 liters of milk and make curds with it.
    b. Remove the Creamy layer on it. Let it remain for 3 to 5 days, so there will be a grey layer of fungus formed.
    c. Churn it well and mix in water, filter and spray on infected trees.
    d. Shelf Life: 3 days
3. **Dry ginger and cow milk solution:**
    a. Take ginger powder and mix it in water.
    b. Boil the solution till it becomes half by volume and let it cool.
    c. Take desi cow milk in a bowl and boil it and remove the cream and let it cool.
    d. Mix both solutions and stir it well with a wooden pole.
    e. After 2 hours you can use it.
    f. Shelf life: 48 hours.

4. Weed Management Practices

a. Name of the practice:

- **i.** Application of well decomposed/fermented compost
- **ii.** Cultural Weed Management
- **iii.** Stale Seedbed Technique
- **iv.** Planting Density
- **v.** Planting Patterns
- **vi.** Cover crops
- **vii.** Intercropping
- **viii.** Mulching
- **ix.** Interculturing Operation
- **x.** Soil Solarisation

b. Brief description of the practice

i. **Application of well decomposed compost:** Improper fermented/decomposed natural input possesses large no of weed seeds. The temperature generated and fermentation process during decomposition reduces the vigour and viability of weed seed. Thus proper decomposition process serves as preventive way of weed management in crop field.

ii. **Cultural Weed Management:** Tillage: Tillage helps in managing weeds by burying weed seeds, emerged weed seedlings and plants as well, as hinder the germination of weed seeds. Depth of tillage also influences the vertical distribution of weed seed in the soil layer

iii. **Stale Seed Bed Technique:** The Emerged weeds are destroyed by following the cultivation practices after primary tillage followed by irrigation or rains. Then crop is seeded with minimum soil disturbance, this method delayed he weed emergence.

iv. **Planting Density:** Higher number of plants gain competitive edge under crop weed competitive situation. More plants broader crop canopy corner cerate higher weed suppression capacity.

v. **Planting Patterns:** The special arrangement of crop plants and variety may affect weed growth for example narrow planting with higher seeding reduces the biomass of later emerging weeds by reducing the available light intensity for weed located below /under the crop canopy. Similarly, fast growing cultivars have a competitive edge over the weeds.

vi. **Cover crops:** The weed build up in field may be reduced with the use of cover crops. Cover crops compete with weeds for sunlight and shade out the weeds as well as cause them not to bloom. In some cases be allopathic to weeds and kill them.

vii. **Intercropping:** Growing of cover crop between rows of main crop and these smother crop suppress weeds. Thus intercropping may be included in the strategies of weed control in organic farming.

viii. **Mulching:** Mulching is a protective covering of material maintained at soil surface, plants leaves plastic sheet, films etc. are used as mulch . It prevent light from reaching to the weeds. Hence it suppress of weed growth.

ix. **Interculturing Operation:** Weeds grown In between crops rows are cut scraped or destroyed by hoe. It inhibit the growth of weeds and reduced the weed population. Inter culture at two and four

weeks in between crops rows serves as effective weed management practice.

x. **Soil Solarisation:** Process involves heating of soil surface by using plastic sheets placed on moist soil in order to accumulate solar radiation in the surface soil which increases the temperature by 8°to 12°C where the summer temperature is more than 40°C. Soil solarisation bring about thermal chemical and biological changes in soil caused by solar radiation. This increased temperature would prove to be lethal to soil pathogens, nematodes and weed seeds.

c. Benefits of the practice (Impacts):

i. Reduce vigour and viability of weed seed and ultimately reduce the weed population
ii. Reduce germination of weed seed and horizontal as well as vertical weed control can be achieved.
iii. Delayed he weed emergence.
iv. Suppression of weeds.
v. Reduces the biomass of later emerging weeds by reducing the available light intensity for weeds located below /under the crop canopy. Similarly, fast growing cultivars have a competitive edge over the weeds.
vi. Cover crops compete with weeds for sunlight and shade out the weeds as well as cause them not to bloom. In some cases be allopathic to weeds and kill the weeds.
vii. Smoother crops as intercrop suppress the weed growth.
viii. Mulches prevent light from reaching the weeds. Hence it suppresses weed growth.
ix. It inhibits the growth of weeds and reduces the weed population.
x. The increased temperature due to soil solarisation proves to be lethal for pathogens, nematodes and weed seeds.

d. Protocols to be followed:

i. **Mulching**: Use organic materials (straw, leaves, or cover crops) to cover the soil. This helps to suppress weed growth by blocking sunlight and conserving soil moisture.
ii. **Crop Rotation and Diversification**: Rotate crops regularly and incorporate diverse species in farming systems to break weed cycles and reduce the build-up of weed populations.

iii. **Intercropping**: Planting different crops together can outcompete weeds by using diverse root structures and canopy layers, making it harder for weeds to establish.
iv. **Manual Weeding**: Regular hand weeding, especially in the early stages of plant growth, prevents weeds from becoming too established.
v. **Living Mulch/Cover Crops**: Plant cover crops (like legumes or grasses) that provide ground cover and outcompete weeds by shading the soil and reducing space for weed growth.
vi. **Soil Health Management**: Focus on maintaining healthy soil through composting, organic matter addition, and minimal tillage. Healthy soil encourages vigorous crop growth, which helps suppress weed growth naturally.
vii. **Natural Herbicides**: Use natural, non-toxic herbicides like vinegar or citrus oils if needed, but these are typically applied selectively and sparingly.

5. Seed selection, treatment and sowing practices

a. Name of the practice:

i. Seed selection: Good quality healthy seed material preferably of local variety should be selected for sowing.
ii. Seed treatment: Seed treatment of beejamrut prepared on-farm with desi cow based inputs should be given to the seed before sowing.
iii. Sowing practice: Seed should be sown at recommended distance and depth.

b. Brief description of the practice

i. **Seed selection:** The seed viability determines the germination capacity, the stand of the crop and its ultimate yield. Mixture can lower the market value of the crop. Hence, the source from which the seed is obtained is critical. Good quality seeds preferably of local variety should be pure, with high germination capacity, uniform seed size, colour and weight, besides being free from seed-borne diseases.
ii. **Seed treatment:** On-farm produced microbial formulation beejamrut prepared form cow based inputs should be used for seed treatment before sowing the seed.

iii. **Sowing practice:** Seed should be sown at recommended spacing and depth of the crop.

c. Benefits of the practice

i. Good and uniform germination with optimum plant stand with very good vigour. Ultimately the production will be higher.

ii. Seed treatment with On-farm produced microbial formulation beejamrut prepared form cow based inputs having several beneficial bacteria, hormones and alkaloids, which enhance seed germination and vigour, seedling length; and provides protection to seeds and seedlings from harmful seed-borne pathogens; other fungus, bacteria and soil borne diseases.

iii. Sowing at with proper depth and spacing maintains optimum plant population per unit area ultimately leads to enhanced production.

d. Protocols to be followed

i. Good quality seed material preferably of local variety having higher germination percentage with lees impurities and uniform in size, shape & colour should be selected for sowing

ii. beejamrut is an ancient, sustainable agriculture technique. It is used for treatments of seeds, seedlings or any planting material. It is effective in protecting young roots from fungus. beejamrut is a fermented microbial solution, with loads of plant-beneficial microbes, and is applied as seed treatment. It is expected that the beneficial microbes would colonize the roots and leaves of the germinating seeds and help in healthy emergence of the plants.

iii. **Inputs needed:** 5 kg cow dung, 5 litre cow urine, 50 gram lime, rhizospheric soil-50 g or handful, 20 litre water (for 100 kg seed or depending on seed size).

iv. **Preparation of beejamrut:**

1. Take 5 kg desi Cow dung and wrap it in a cotton cloth
2. Take 20 litre water in bucket and dip the above 5 kg cow dung wrapped in cloth into it.
3. Leave it for 12 to 16 hours so that the cow dung extract may come into the water
4. Take 50 gm lime in another container having 1 litre water
5. Now mix the above two preparations and into it add 50 gm rhizospheric soil
6. Add 5 litre of cow urine into it and leave the solution prepared for 8-12 hours

7. Now the beejamrut is ready for seed treatment

v. **Method of Application for seed treatment:** Add beejamrut to the seeds (300 ml/kg seed) of any crop; coat them, mixing by hand; dry them well and use them for sowing. For leguminous and other plant seeds which have thin seed coats, always use bamboo baskets for placing the seeds and just dip them in beejamrut solution and allow the treated seeds for drying in shade.

6. Cropping systems

a. Name of the practice:

i. Mix cropping
ii. Intercropping
iii. Crop diversification
iv. Crop rotation
v. Agroforestry

b. Brief description of the practice

i. In this system, two or more crops are grown together in the same field at the same time without definite row pattern. The crops are selected in such a way that they do not compete with each other for resources.

ii. This system involves growing two or more crops on the same piece of land at the same time with definite row pattern. Intercropping can help to reduce soil erosion, increase soil fertility, and provide a diverse range of crops.

iii. Crop diversification is the practice of growing a variety of crops in a given area to improve farm resilience, reduce risks, and enhance productivity. It helps prevent the negative impacts of pests, diseases, and market fluctuations. By rotating crops with varying growth cycles and resource needs, farmers can optimize land use and reduce dependency on a single crop, leading to more sustainable and profitable farming systems.

iv. Crop rotation involves growing different crops in a specific sequence on the same piece of land. This system helps to maintain soil fertility, prevent pest and disease build up, and reduce the need for synthetic fertilizers and pesticides.

v. In this system, trees or shrubs are planted in a field along with crops. The trees provide shade and help to prevent soil erosion, while the crops provide a source of income.

c. **Benefits of the practice**

i. **Mixed cropping**

1. **Increases Soil Fertility:** Specific nutrients in the soil are depleted when the same crop variety is planted repeatedly. Each variety of crops interacts differently with the soil's nutrients and releases and absorbs various nutrient types. Because crop rotation replaces nutrients that are unavailable or absorbs nutrients that are abundant, it promotes soil fertility by regulating deficiency or excess nutrients.
2. **Increases Crop Yield:** The harvest from a single seasonal harvest is increased by the cropping pattern. Because several crop varieties are used, one receives a general bountiful harvest each season in addition to a variety of crops. Scientific research shows that crop rotation, as opposed to monoculture, increases crop output by 10% to 25%.
3. **Increases Soil Nutrients:** Cropping patterns enable the soil to replenish and renew its own nutrients without the need to use fertilizers to add extra nutrients. A season of bare land allows the earth to replenish the nutrients lost through plant absorption during the previous season's harvest.
4. **Reduces Soil Erosion:** Plants help to reduce water droplet impact on the soil and erosion by water by holding the top layer of soil together. Planting trees and crops together in the farmlands helps to prevent soil erosion.
5. **Improves the Soil Structure:** Cropping patterns can help prevent soil compaction, which can improve the physical condition of the soil. Crop rotation helps to improve the soil structure and texture. This allows good conditions for seed germination and root growth.
6. **Diversification and Reduced Cost of Production:** Cultivation of certain crops requires less labour and machinery compared to other crops. It helps to spread the workload and resources used throughout the year, which reduces the cost of production of crops.

ii. **Intercropping :** Intercropping can promote climate resilience through higher plant resource efficiency (space, nutrients, and water) and natural suppression of insect pests, pathogens, and weeds. Together, these impacts often enhance profitability for

farmers, despite increasing the complexity of management and increasing the need for labour.

iii. **Crop diversification :** Crop diversification provides better conditions for food security and enables farmers to grow surplus products for sale at market and thus help to obtain increased income to meet other needs related to household well-being. Crop diversification can enable farmers to gain access to national and international markets with new products, food and medicinal plants. Diversifying from the monoculture of traditional staples can have important nutritional benefits for farmers in developing countries and can support a country for becoming more self-reliant in terms of food production. Diversification can also manage price risk, on the assumption that not all products will suffer low market prices at the same time and increase the profitability of the farming community.

iv. **Crop Rotation**

1. **Soil Properties:** Rotations that include crops such as legumes or perennial grasses can add considerable organic matter to the soil by decomposition of above and below ground plant material. These roots maintain or increase soil humus (long-lasting organic matter).
2. **Nitrogen Contributions from Legumes:** When used strategically in a rotation, legumes such as alfalfa or soybeans provide nitrogen to the subsequent crop. A legume is typically followed by a high nitrogen-demanding crop such as corn or wheat. The amount of nitrogen that a legume crop contributes to following crops depends on the amount of nitrogen fixed, the maturity of the legume when it was killed or incorporated into the soil, whether the entire plant or only the root system remains in the field, and the environmental conditions that govern the rate of decomposition.
3. **Nutrient Recycling:** Crop rotations that integrate deep-rooted crops with shallow-rooted crops can help cycle nutrients in the soil profile. The deep-rooted crops absorb nutrients from deep in the soil profile and move them to the plant's top growth. As crop residues are returned to the surface soil, these newly "mined" nutrients are potentially available to future crops.
4. **Disease Management:** Crop rotation can be an effective disease management tool, particularly if the pathogen has a

narrow host range and overwinters in crop residue or soil. Crop rotation can decrease the level of inoculum present by introducing a crop that is not a host to the pathogen.

5. **Insect Management:** Rotating crops may help manage some insect pests. Crop rotations are most effective against insects that are fairly non-mobile, that feed on a narrow range of crops, and that overwinter in the soil as eggs or larvae.
6. **Weed Management:** Crop rotation provides the foundation for long-term organic weed management. Planting a wide variety of crops with varied characteristics reduces the likelihood that specific weed species will become dominant, and even “trap” weeds into life-cycle dead ends that curtail reproduction.
7. **Soil Moisture Utilization:** Crop rotation can lead to greater overall efficiency in soil water utilization. For example, deep-rooted crops such as sunflower following small grains can take advantage of the extra reserve of deep moisture and also any nitrogen that was not available to a shallow-rooted crop.
8. **Improvement in Crop Yields:** Yields are higher when a crop different than the preceding crop is grown.
9. **Added Benefits:** Crop rotations can balance the production of crop residues when crops that produce durable residue (such as corn) are rotated with crops that produce more fragile residue (such as soybean).

v. Agroforestry

1. **Environmental benefits:** Agroforestry systems offer a range of ecological benefits when compared to conventional full-area farming. It facilitates better utilisation of groundwater, which is crucial in maintaining the water table and ensuring sustainable water use. Additionally, agroforestry reduces nutrient leaching into nearby water bodies, which is a common environmental concern associated with intensive farming practices. Agroforestry also reduces soil erosion on farms, helping preserve soil health and structure. Importantly, these systems enhance biodiversity, providing habitats for various species and improving the ecological balance. This is particularly the

case with more complex systems such as multistrata agroforestry.

2. **Productivity:** Ultimately, healthy and nutrient-dense soils can provide larger yields and greater resilience to droughts, floods, pests, and diseases, leading to higher and more consistent returns. They also serve a practical function by providing wind protection for crops and shelter for livestock, thus reducing crop loss and improving animal wellbeing.
3. **Economic considerations:** Agroforestry systems can offer diverse revenue sources for farmers. Trees are a valuable resource, and farmers can harvest and sell materials such as timber, firewood, fruits, and more. Furthermore, healthier soils negate the need for excessive pesticide and fertiliser use, thus lowering inputs costs. There is also a growing bank of grants and private investment options for farms that adopt sustainable practices.
4. **Social:** Agroforestry can also help address the aesthetic issues associated with monoculture farming. Almost by definition monoculture farming is prone to creating monotonous, unattractive, and bland terrains. The integration of tree strips into these landscapes significantly improves the aesthetic appearance of the farmland. This not only makes the farmland more visually appealing, but it can also contribute to the overall well-being of communities living in and around these areas and help build a more positive perception of agriculture within the community.

d. Protocols to be followed

i. Mixed cropping

1. It is best to grow one tall and one dwarf crop at the same time. The nutrient requirements of one crop should be lower than those of the other. One crop's roots should be deep, while the roots of the other crops should be shallow. All of these elements work together to create a successful mixed cropping pattern.

ii. Intercropping

1. When two or more crops are combined in a field, plant densities need to be adapted to maximize yields. If full rates of each crop were planted, neither would yield well because of intense over-crowding. In intercropping systems, it is an

advantage if the different crops in the mixture have different maturity dates, with different times of peak demand for nutrients, water and sunlight, thereby reducing competition. It is useful to pay attention to differences in plant architecture between the crops given that different crops may have a different architecture, i.e. height and width of the plant.

iii. Crop rotation

1. By Plant Family: Rotate different plant families seasonally, often over four years.
2. By Plant Part Harvested: Alternate between legumes, leaves, fruits, and roots.
3. By Plant Compatibility: Pair complementary plants, like sweet corn before potatoes for better yields.
4. By Nutrient Requirements: Start with legumes, followed by heavy feeders like tomatoes or corn.
5. By Rooting Depth: Alternate deep-rooted plants (e.g., beets) with shallow-rooted ones (e.g., cauliflower).
6. Include Legumes and Cover Plants: Use grasses or small grains in fall to reuse nitrogen, enriching soil for the next crop.

iv. Crop diversification

1. Use Local Varieties: Grow native or heirloom crops suited to the local environment.
2. Complementary Planting: Pair crops with different growth habits (e.g., beans with corn) to maximize space and nutrient use.
3. Integrate Livestock: Use animals for manure and pest control, rotating grazing areas for soil regeneration.
4. Soil Health: Use cover crops and minimal tillage to protect and enhance soil fertility.
5. Water Conservation: Choose drought-resistant crops and use mulching and rainwater harvesting.
6. Local Seeds and Knowledge: Use locally adapted seeds and engage in community knowledge sharing.

v. Agroforestry

1. Biodiversity: Include diverse tree species to enhance ecosystem resilience.
2. Soil Health: Use trees to improve soil structure and nutrient cycling.

3. Complementary Relationships: Select trees that support crops with shade or nitrogen fixation.
4. Water Management: Trees help retain water and reduce runoff.
5. Local Adaptation: Choose native or climate-suited tree species.
6. Minimal Input: Focus on low-maintenance, sustainable practices.
7. Economic Viability: Incorporate trees that offer marketable products.
8. Integration with Livestock: Use trees to support sustainable livestock systems.

7. Water Management practice

a. Name of the practice

- **i.** In-situ and ex-situ moisture conservation
- **ii.** Rain water harvesting and recycling
- **iii.** Micro irrigation
- **iv.** Drainage in-situ and ex-situ
- **v.** Water budgeting
- **vi.** Traditional knowledge base

b. Brief description of the practice

- **i.** **In situ moisture conservation** involves techniques that retain and manage water within the soil where it falls. Methods include mulching, cover cropping, contour ploughing, and terracing. These practices help reduce runoff, improve soil structure, and enhance water retention directly in the field.
- **ii.** **Ex situ moisture conservation** refers to water conservation methods that occur outside the immediate growing area. This includes practices like rainwater harvesting, building water storage systems (e.g., ponds, tanks), and using stored water for irrigation when needed. It ensures water availability for crops during dry periods.
- **iii.** **Rainwater harvesting** is the process of collecting and storing rainwater for later use. It involves capturing rain from rooftops or other surfaces, directing it into storage tanks or reservoirs. This harvested water can be used for irrigation, drinking, or other

household needs, reducing dependence on groundwater or municipal water sources.

iv. **Rainwater recycling** refers to the process of filtering and reusing collected rainwater for non-potable uses, such as irrigation, flushing toilets, or washing. It reduces water wastage and supports sustainable water management by reusing water within a system.

v. **Micro irrigation system** is a water-efficient irrigation method that delivers water directly to the root zone of plants in small, controlled amounts. It includes systems like drip irrigation, where water is dripped slowly through tubes or hoses, and sprinkler systems with fine water spray. This method reduces water wastage, minimizes evaporation, and ensures that plants receive precise and adequate water, making it ideal for areas with limited water resources.

    1. **In-situ drainage** refers to the management of excess water within the soil at the location it is generated. It includes practices like surface drainage (e.g., ditches, furrows) and sub-surface drainage (e.g., tile drains) that help remove water from the soil to prevent waterlogging and improve soil aeration for crops.
    2. **Ex-situ drainage** involves removing excess water from the area and managing it outside the immediate field. This can include constructing channels or reservoirs to divert and store runoff water, or creating detention basins to hold water temporarily and prevent flooding in agricultural areas.

vi. **Water budgeting** is the process of estimating and managing the total water available and required for agricultural, industrial, or household use within a specific area. It involves calculating inputs (e.g., rainfall, water sources) and outputs (e.g., evaporation, transpiration, irrigation needs) to ensure efficient water usage. By balancing water supply and demand, water budgeting helps optimize resource allocation, reduce wastage, and ensure sustainable water management.

vii. **Traditional knowledge** on water management in agriculture refers to age-old practices and techniques developed by local communities to efficiently manage water resources for farming. These methods are often based on deep understanding of local climate, soil, and water systems. Examples include:

    1. Rainwater harvesting using ponds or wells to capture and store water for dry seasons.

2. Water diversion techniques like canals and channels to direct water to crops.
3. Terracing on slopes to reduce water runoff and soil erosion.
4. Flood irrigation using gravity to irrigate fields in low-lying areas.
5. Use of indigenous plants that are drought-resistant and require less water.
6. These practices are sustainable, region-specific, and have been passed down through generations, ensuring efficient water use and enhancing agricultural resilience.

c. Benefits of the practice (Impact)

i. In situ moisture conservation
1. Reduces water runoff
2. Improves soil structure
3. Sustainable
4. Cost-effective

ii. Ex situ moisture conservation
1. Water storage
2. Reduces dependency on rainfall
3. Enhances crop productivity
4. Supports large-scale farming

iii. Rainwater harvesting
1. Reduces dependence on external water sources
2. Cost-effective
3. Improves water availability
4. Prevents flooding

iv. Rainwater recycling
1. Conserves fresh water
2. Reduces water wastage
3. Cost savings
4. Sustainable

v. Micro irrigation systems
1. Water efficiency: Delivers water directly to the plant roots, minimizing waste and evaporation.
2. Improved crop yield: Ensures precise water distribution, promoting healthy plant growth.
3. Reduced labour costs: Automates irrigation, reducing the need for manual labor.

4. Energy savings: Requires less energy compared to traditional irrigation methods.
5. Sustainable: Optimizes water use, making it ideal for areas with limited water resources.

vi. Drainage

1. In-situ drainage system:
    a. Prevents waterlogging: Improves soil aeration by removing excess water.
    b. Improves soil fertility: Reduces salinity and maintains proper moisture levels for crops.
    c. Low cost: Uses natural topography and minimal infrastructure.
2. Ex-situ drainage system:
    a. Reduces flooding risk: Diverts excess water away from fields and low-lying areas.
    b. Increases land usability: Makes waterlogged land cultivable by controlling water levels.
    c. Enhances agricultural productivity: Maintains ideal soil conditions for crops by managing runoff water.

vii. Water budgeting

1. Efficient water use: Ensures optimal allocation of water resources for agriculture, industry, and households.
2. Prevents overuse: Helps avoid water scarcity by balancing supply and demand.
3. Improves sustainability: Supports long-term water conservation and resource management.
4. Cost savings: Reduces waste and minimizes water-related expenses.
5. Enhances crop productivity: Ensures consistent water availability for agriculture, especially during dry periods.

viii. Traditional knowledge

1. Sustainability: Promotes long-term, eco-friendly water use without depleting resources.
2. Cost-effective: Utilizes low-cost, locally available materials and techniques.
3. Resilience: Enhances farm resilience to droughts and floods through adaptive practices.
4. Preservation of ecosystems: Maintains soil health and water cycles in balance with nature.

5. Cultural preservation: Strengthens community connections by passing down water management techniques.

d. Protocols to be followed

i. In situ and ex situ moisture conservation

1. Mulching: Apply organic or synthetic materials on soil surface to reduce evaporation and retain moisture.
2. Water harvesting: Collect rainwater through techniques like rain barrels or ponds for later use in dry periods.
3. Cover crops: Plant legumes or grasses to improve soil structure, reduce evaporation, and enhance water retention.
4. Soil management: Practice minimal tillage, maintain soil organic matter, and use organic fertilizers to improve water-holding capacity.
5. Contouring: Use terracing or contour ploughing to slow down water runoff and promote absorption.
6. Micro irrigation: Implement drip or sprinkler systems to provide water directly to plant roots efficiently.
7. Windbreaks: Plant trees or shrubs around fields to reduce water loss from wind evaporation

ii. Rain water harvesting and recycling

1. Collection surfaces: Use clean, durable surfaces like rooftops to collect rainwater.
2. Gutter system: Install gutters and downspouts to direct rainwater into storage containers or tanks.
3. Filtration: Implement filters to remove debris and contaminants from collected water.
4. Storage: Use appropriate storage systems like tanks, ponds, or cisterns to store the harvested water.
5. Overflow management: Design overflow channels to safely redirect excess water.
6. Regular maintenance: Clean gutters, filters, and storage tanks to ensure water quality and system efficiency.
7. Usage: Use harvested rainwater for irrigation, non-potable domestic purposes, or recharging groundwater.

iii. Micro irrigation system

1. System design: Plan the layout of drip lines or sprinkler heads to ensure efficient water distribution across the field.
2. Water source: Ensure a reliable water source, like wells or rainwater harvesting, for the irrigation system.

3. Filtration: Install filters to prevent clogging of emitters and pipes from debris or sediment.
4. Emitter selection: Choose the right emitters (drip emitters, micro-sprinklers) based on crop type and water needs.
5. Pressure regulation: Use pressure regulators to maintain consistent water flow and avoid system damage.
6. Maintenance: Regularly check for blockages, leaks, and replace worn parts to keep the system functioning efficiently.
7. Scheduling: Set irrigation schedules based on crop requirements and weather conditions to minimize water wastage.

iv. Drainage

1. System Design: Plan for proper drainage to avoid waterlogging, ensuring that excess water can flow out of the system.
2. Drainage Channels: Install surface or subsurface drainage channels to direct excess water away from crops.
3. Outlet Placement: Position drainage outlets at low points of the field to efficiently remove surplus water.
4. Regular Maintenance: Inspect and clear drains regularly to prevent blockages and ensure proper water flow.
5. Soil Assessment: Evaluate soil types and adjust drainage systems to suit different soil permeability for better water management.
6. Water Flow Control: Use valves or gates to regulate drainage flow and prevent soil erosion or flooding.

v. Water budgeting

1. Assess Water Availability: Evaluate local water sources (rainfall, groundwater, surface water) and their seasonal variations.
2. Estimate Water Needs: Calculate water requirements for different crops, livestock, and domestic uses based on climate, soil, and crop type.
3. Set Priorities: Allocate water based on urgency, ensuring critical needs (e.g., drinking water, essential crops) are met first.
4. Monitor Usage: Regularly track water consumption to detect inefficiencies and adjust accordingly.

5. Promote Conservation: Implement water-saving practices like efficient irrigation, rainwater harvesting, and reducing waste.
6. Adapt to Changes: Adjust the water budget based on changes in weather patterns, crop cycles, or water availability.

vi. Traditional knowledge

1. Rainwater Harvesting: Collect rainwater using traditional methods like ponds, wells, and water storage tanks.
2. Water Diversion: Use canals and channels to direct water to fields and crops, often based on local topography.
3. Terracing: Build terraces on slopes to reduce water runoff, minimize soil erosion, and retain moisture in the soil.
4. Soil Moisture Retention: Use natural mulching techniques, such as crop residues or organic materials, to conserve soil moisture.
5. Water-efficient Crops: Grow drought-resistant crops that require less water and are adapted to local climate conditions.
6. Integrated Water Management: Combine practices like agroforestry, crop rotation, and natural irrigation systems for sustainable water use.

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Annexure- V

Anand Agricultural University, Anand, Gujarat
Natural Farming Package of Practices

1. Natural Farming Practices

a. Soil Health Management practices

i. **Name of practice:** Mulching and Intercropping

ii. **Brief description of the practice:** Mulching with straw enhances soil moisture and encourages microorganisms and earthworms as well as fostering seed germination. Comprising dried biomass waste or any dry organic material, it contributes to improve soil fertility by decomposing through microbial activity**.**

iii. **Benefit of the practices:**

1. Sustain and improve the soil organic carbon
2. Increase soil microbial population
3. Regulate soil temperature
4. Improve Water Holding Capacity (WHC) and sustain soil moisture
5. Reduce weeds population

iv. **Protocols to be followed:** Keeping soil surface covered year around with the help of crop residues available in the farm.

v. Inter-cropping of cereal crops with pulses/oilseed [e.g. Wheat + Chickpea (4:2), Maize + Soybean (2:3)].

b. Nutrient management practices

i. **Name of practice:** Ghan jivamrut, Jivamrut and Intercropping

ii. **Brief description of the practice:** Jivamrut and Ghan jivamrut rich in nutrients like carbon, nitrogen, phosphorus, calcium etc. It boosts soil microorganisms, enhancing soil fertility and crop yield. It's made from cow dung and urine, promoting nutrient availability and microbial activity. This leads to an increasing earthworm population in soil. Soil microorganisms actively impact by cycling nutrients like carbon and nitrogen which is essential for plant growth.

iii. **Benefit of the practices:**

1. Enriches the soil with nutrients
2. Sustain and improve the soil organic carbon
3. Addition and fulfil the nutrients requirement of different crops
4. Increase soil microbial population
5. Improve WHC

iv. **Protocols to be followed:**

1. 2 t/ha FYM once in a year during kharif season (when 1st time starting of NF and then reduce FYM @ 25 % from subsequent years)
2. 2 t/ha Ghan jivamrut before sowing of the crops in each season as soil application
3. Soil application of 1250 L/ha Jivamrut at the time of sowing thereafter every 15 days apply in the soil.
4. Foliar application of jivamrut 1.0 litre/10 litre of water at 20 days after sowing and jivamrut 2.5 litre/10 litre of water at 40 and 60 days after sowing.

c. Pest and disease management practices:

i. **Name of practice:** Agniastra, Brahmastra and Neemastra

ii. **Brief description of the practice:** To control the sucking and other pest

iii. **Recommendations for farmers: (**For effective management of root-knot nematodes in tomato**).** Farmers growing tomato in middle Gujarat are recommended to apply Agniastra 800 mL in 10 litres of water and then dip the seedling roots for six hours. Thereafter, drench 500 mL Agniastra solution per plant at the time of transplanting and at 15, 30 and 45 days after transplanting for effective management of root-knot nematodes. The method for preparation of Agniastra is mentioned below :

Ingredients	Required Quantity
Cow urine (desi)	20 L
Neem leaves paste	5 kg
Garlic paste	500 g
Green chillies paste	500 g
Tobacco dust	1 kg

- Mix all the ingredients together in a vessel and boil it 4-5 times continuously at medium flame and keep it for 48 hrs. Filter this by cloth and then use it.

iv. **Benefit of the practices:** To prevent/control the pest with nature based low-cost product

v. **Protocols to be followed:**

1. Spraying of liquid formulation (400 ml /10 litre of water) at pest incidence occur

2. Sowing of yellow marigold flower in field as a trap crop
3. Spraying of prepared solution (10 days old buttermilk dip with copper road or wire for 10 days) @ 5 % at 45 and 60 DAS for disease control

d. Weed management practices

i. Name of practice: Mulching, Intercropping and stale seedbed technique

ii. Brief description of the practice: Mulch and intercropping is a highly effective tool for weed control in natural farming systems. It works by blocking light, preventing seed germination, regulating moisture and temperature and even enhancing soil health. This reduces the need for manual weeding, creating a more sustainable and eco-friendly farming system.

iii. Benefit of the practices:

1. Mulching : It blocks sunlight, inhibiting the germination of weed seeds by creating a physical barrier.
2. Intercropping: It creates a more diverse environment where weeds have to compete for light, water, and nutrients.

iv. Protocols to be followed:

1. In stale seedbed technique, allowing weed seeds to germinate and then killing them before sowing of crop with the help of tillage
2. Mulching with available on farm crop residues
3. Inter-cropping in cereals crops with pulses/oilseeds
4. Use weed free seeds
5. Add mulching material 10 days after sowing so that germination is not affected

e. Seed selection, treatment and sowing practices

i. Name of practice:

1. Use of desi/improved varieties of seeds
2. Seed treatment with Beejamrut
3. Drilling, Broadcasting and Sibling etc.

ii. Brief description of the practice: These traditional varieties are often better suited to the local environment, as they have evolved over generations to withstand local pests, diseases, climate and soil conditions. Bijamrut is an essential component of natural farming that promotes healthier crops. Bijamrut made from natural inputs like cow urine and cow dung, it improves seed germination,

enhances plant growth and fosters a sustainable farming ecosystem.

iii. **Benefit of the practices:**
   1. Low infestation of pests and diseases
   2. High nutritive value
   3. Better germination
   4. The microbial activity in Bijamrut helps to reduce the incidence of soil-borne diseases

iv. **Protocols to be followed:**
   1. Use of deshi and improved varieties
   2. Treat the seeds with 300 mL Bijamrut/kg of seeds before 8-10 hrs of sowing

f. Cropping systems

i. **Name of the practice:** Intercropping

ii. **Brief description of the practice:** e.g. Maize + Soyabean (2:3) and Wheat + chickpea (4:2) intercropping pattern.

iii. **Benefit of the practices:** Intercrops helps to restore soil fertility when legumes are included as component crops. Suppress the weeds as well as reduce soil erosion, as the soil remains covered with plants.

iv. **Protocols to be followed:** Inter-cropping of cereal crops with pulses/oilseed [e.g. Wheat + Chickpea (4:2), Maize + Soyabean (2:3)].

g. Water management practices

i. **Name of the practice:** Check basin

ii. **Brief description of the practice:** Due to good source of irrigation water in area, irrigation provided through check basin method.

iii. **Benefit of the practices:**
   1. Uniform distribution of water is possible

iv. **Protocols to be followed:** Proper size of bund height is required. Length and width of the basin depending on the slope of the field.

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Annexure- VI

Gujarat Natural Farming Science University (GNFSU), Halol, Gujarat

Soil health management practices

i. Name of the practice:

1. jeevamrut and ghan jeevamrut
2. Residue Mulching
3. Permanent (365 Days) Soil Cover/ Pre-Season Dry Sowing
4. Minimum Soil Disturbance
5. Crop Diversification

ii. Brief description of the practice:

1. Jeevamrut and ghan jeevamrut are rich in beneficial microbes, such as bacteria, fungi and actinomycetes. These microbes improve the soil biological activity, leading to a dynamic and healthy soil ecosystem. Regular application increases microbial population and interactions, which are essential to control plant pathogens, accelerate organic matter decomposition and nutrient cycling.

2. Residue mulching is a vital practice for improving and maintaining soil health by creating a protective organic layer on the soil surface. This layer reduces erosion of nutrients, prevents water loss through evaporation which also controls salinity, and moderates soil temperature, providing a stable environment for soil biota (Microbes and Earthworms). As the mulch decomposes, it adds organic matter to the soil, enriching it with nutrients and increasing soil organic carbon (SOC) content. This process stimulates microbial activity in the rhizosphere, enhancing nutrient cycling and the formation of humus, a stable organic substance that improves soil structure, nutrient availability and water-holding capacity.

3. Maintaining a 365-day soil cover through plantations provide a continuous supply of root exudates, creating a dynamic interface between plants and soil microbes that significantly enhances soil organic carbon. Additionally, plant diversity supports microbial diversity by providing different habitats and resources, which helps create a balanced soil microclimate. The living roots exude compounds like sugars, amino acids, and organic acids, which act as energy sources for soil microorganisms, stimulating their activity and facilitating the decomposition of organic matter. This process contributes to nutrient cycling and the formation of stable SOC pools, essential for soil fertility and carbon sequestration. Moreover, year-round soil cover minimizes erosion

and organic matter loss, protects soil from temperature extremes, and supports a diverse microbial community, all of which synergistically enhance SOC, nutrient cycling and promote long-term soil health. Moreover, Various mycorrhizal fungi associate with nearly 90% of global plant species, relying on living roots which reciprocate by supplying nutrients and water from the soil to the roots.

4. Conventional tillage practices lead to the disruption of soil aggregates in surface layers and increases aeration, which reduces total carbon by microbial decomposition of soil organic carbon to CO2 particularly in macroaggregates. Additionally, adoption of zero tillage reduces the number of micro pores (15-150 μm) in the soil, which is crucial for microbial activity thereby improving the physical conservation of soil organic carbon. Therefore, by minimizing soil disturbance through the adoption of zero tillage practices, it is anticipated that CO2 emissions from the soil to the atmosphere can be reduced, contributing to the mitigation of global climate change and improve soil organic carbon status. Zero tillage seeding systems without disturbing the soil surface maintains optimum proportions of gaseous exchange in the rooting-zone, reduces C losses as atmospheric CO2, moderates organic matter oxidation, improves porosity for water movement and limits the germination of weed seeds.

5. Crop diversification positively impacts soil health by enhancing soil biodiversity, improving nutrient cycling, and reducing pest and disease pressures. Different crops have varying root structures and nutrient requirements, which promote a more balanced use of soil nutrients and prevent depletion. Deep-rooted crops can bring nutrients from deeper soil layers to the surface, while including legumes in crop diversification significantly enhances soil health due to their unique ability to fix atmospheric nitrogen through symbiotic relationships with soil bacteria. This natural nitrogen enrichment eliminates the need for synthetic fertilizers, improving soil fertility sustainably. Additionally, legume root systems contribute organic matter to the soil, enhancing its structure, water-holding capacity, and microbial activity. In mixed cropping systems, legumes help balance nutrient dynamics, support other crops' growth, and suppress weeds. By preventing soil exhaustion and fostering a diverse microbial ecosystem, legume-based diversification is a cornerstone for long-term soil health and productivity.

iii. Benefits of the practices (impacts):

1. The application of jeevamrut and ghan jeevamrut enriches the soil with beneficial microbes, as demonstrated by metagenomic findings in natural farming soils, showcasing their crucial role in improving soil health and nutrient availability. These bio-inputs foster a diverse microbial ecosystem, including dominant groups like Proteobacteria, Actinobacteria, Firmicutes, and Cyanobacteria, which are essential for

biogeochemical processes such as nutrient cycling and organic matter decomposition. At the genus level, microorganisms like Streptomyces, Bacillus, Pseudomonas, and Rhizobium are particularly prominent in Natural Farming soil. Streptomyces and Bacillus enhance phosphorus solubilization, while Pseudomonas supports plant growth through the production of phytohormones and bioactive substances. Rhizobium is instrumental in nitrogen fixation, converting atmospheric nitrogen into bioavailable forms for plants. Metagenomic analysis also reveals an increase in the relative abundance of genes linked to critical metabolic functions, such as hydrolase, isomerase, and ligase, reflecting a robust microbial community with enhanced functional capacity. These enzymes accelerate the decomposition of organic matter, releasing vital nutrients like nitrogen, phosphorus, and trace elements into the soil. This dynamic microbial activity underpins the improvement of soil health, ensuring sustainable nutrient availability and fostering resilient agricultural productivity.

2. The Residue mulch layer reduces the impact of rain and wind on the soil, significantly minimizing erosion and nutrient runoff. By keeping nutrients in place, it ensures their availability for plant uptake, a critical factor in nutrient-depleted soils often encountered in conventional farming. Mulching reduces water loss through evaporation by providing a barrier between the soil and the atmosphere. This not only conserves water but also helps maintain a balanced soil moisture level, crucial for microbial activity and plant growth. By preventing excess evaporation, mulching also mitigates salinity buildup, which can occur due to rising salts in the absence of adequate soil moisture. Mulch acts as an insulating layer, moderating soil temperature by keeping it cooler during hot periods and warmer during colder seasons. This stable environment is conducive to the thriving of soil biota, including microbes and earthworms, which play a vital role in soil fertility and nutrient cycling. As the mulch decomposes, it adds organic matter to the soil, enriching it with essential nutrients and increase SOC levels. This increase in SOC not only improves soil fertility but also contributes to carbon sequestration, a critical component of climate change mitigation strategies. The decomposition of mulch fuels microbial activity in the rhizosphere, leading to enhanced nutrient cycling. Microbes decompose organic residues into simpler compounds, making nutrients readily available to plants. This process also promotes the formation of humus, a stable organic substance that further enriches the soil. The addition of organic matter through mulching enhances soil aggregation, resulting in better soil structure. This improved structure increases the soil's water-holding capacity, reducing the need for frequent irrigation while providing a more consistent water supply to plants.

3. Plant diversity within a soil cover supports microbial diversity by providing a range of habitats and resources. Different plants exude different compounds that attract specific microbial communities, leading to a more varied and resilient soil ecosystem.

This diversity promotes a balanced soil microclimate, which is key to long-term soil health. By fostering beneficial microorganisms, such as nitrogen-fixing bacteria, mycorrhizal fungi, and decomposers, the soil's nutrient cycling processes are enhanced. Pre-season sowing aids in nutrient cycling by facilitating the release of nutrients trapped in organic matter. Microbes play a central role in breaking down plant residues and releasing essential nutrients like nitrogen, phosphorus, potassium and micronutrients, which are then available for the next crop. A year-round soil cover, provided by cover crops or pre-season sowing, ensures a constant supply of root exudates, such as sugars, amino acids, and organic acids. These exudates act as a continuous energy source for soil microorganisms, promoting their activity and enhancing the decomposition of organic matter. This results in improved SOC content, essential for maintaining soil fertility, enhancing microbial diversity, and supporting nutrient cycling. By continuously covering the soil with plant roots, organic matter is steadily added through root growth, decay, and the breakdown of plant residues. This process significantly contributes to the formation of stable SOC pools, which improves soil fertility and provides a natural means of carbon sequestration, crucial in the fight against climate change. The presence of living roots also helps to reduce soil erosion. By keeping the soil covered throughout the year, the roots of cover crops help bind the soil particles, reducing the risk of erosion caused by wind or water. Cover crops protecting the soil from extreme temperatures. During hot weather, they reduce soil evaporation and heat stress on soil microbes and plant roots, while in colder months, they help retain warmth. This temperature moderation creates a more stable environment for soil biota, enhancing microbial activity and soil health. A stable temperature range also encourages the continued breakdown of organic matter, supporting nutrient availability. Cover crops with taproots can create macro pores and alleviate compaction. Fibrous-rooted cover crops can promote aggregation and stabilize the soil. Species of cover crops that host mycorrhizal fungi can sustain and increase the population of these beneficial fungi.

4. Soil aggregates are formed through the interaction of organic matter, clay minerals, microbial products, and soil fauna activity. The physical protection of organic carbon occurs when organic matter, such as decomposed plant residues, is incorporated into these aggregates. This encapsulated carbon is shielded from rapid microbial degradation, as the structure of aggregates limits the access of microbes to the organic matter contained within. Microaggregates, which form within macroaggregates, play a significant role in this process. These microaggregates provide a physical barrier that prevents microorganisms from breaking down the organic carbon quickly. As a result, the carbon within aggregates is more stable and is slowly mineralized over a much longer time frame. Conventional tillage, a common practice in many agricultural systems, disrupts the natural aggregation of soil particles, particularly

in the surface layers. This disruption increases aeration in the soil, making organic matter more accessible to soil microbes, which leads to accelerated microbial decomposition of organic carbon. As a result, tillage practices often lead to the loss of organic carbon in the form of CO2 emissions, contributing to climate change. The disruption of aggregates also reduces the soil's ability to physically protect organic carbon, as the organic matter is no longer encapsulated within stable aggregates.

In contrast, zero tillage, a core principle in natural farming, minimizes soil disturbance and preserves the integrity of soil aggregates. Under zero tillage, the soil is left undisturbed, allowing for the natural formation and stabilization of aggregates. This practice maintains the physical protection of organic carbon within aggregates by preventing the disruption of microaggregates and macroaggregates. The organic carbon These aggregates are shielded from rapid decomposition, as microbes are unable to penetrate the dense structure of aggregates, where oxygen and water levels are low, inhibiting microbial activity. Zero tillage also helps maintain the soil's natural porosity, including the formation of micropores, which are crucial for microbial activity and the efficient breakdown of organic matter. These micropores, which are reduced in conventional tillage, help create a favourable environment for soil biota, supporting the process of nutrient cycling and the stabilization of organic carbon.

5. Legumes are central to the principles of natural farming, especially because of their ability to fix atmospheric nitrogen through a symbiotic relationship with nitrogen-fixing bacteria (such as Rhizobium) in their root nodules. This process naturally enriches the soil with nitrogen, an essential nutrient for plant growth, without the need for synthetic fertilizers. The ability of legumes to supply their own nitrogen is particularly important in systems that aim for sustainability and minimal external inputs. By incorporating legumes into crop diversification systems, natural farmers can significantly reduce their reliance on chemical fertilizers, thus minimizing environmental pollution and reducing the cost of production. Moreover, legumes contribute organic matter to the soil, which improves soil structure, increases water retention, and promotes microbial activity—further supporting soil health and fertility. Natural farming is rooted in the idea that farming should work in harmony with natural ecosystems, rather than relying on artificial inputs. Crop diversification is a fundamental practice in natural farming that encourages biodiversity at both the plant and microbial levels. A variety of crops supports a broader range of soil organisms, such as earthworms, fungi, and bacteria, which work together to maintain soil structure and health. By planting different crops, natural farmers create an environment in which these organisms can thrive, ultimately enhancing soil fertility and its resilience to disturbances. Crop diversification improves nutrient cycling by using plants with different nutrient requirements. Some crops take up specific nutrients, while others can replenish or balance the nutrients in the soil. For

instance, deep-rooted crops (such as trees or certain vegetables) access nutrients from deeper soil layers that may not be available to shallow-rooted crops. This helps prevent nutrient depletion in the upper soil layers. As crops like legumes fix nitrogen from the air, they contribute directly to soil fertility without the need for external inputs like synthetic fertilizers. This supports a more balanced and sustainable nutrient cycle that relies on the natural processes of soil Organisms.

iii. Protocols to be followed:

1. Preparation of jeevamrut
   Indigenous cow dung 10 kg
   Indigenous cow urine 8 - 10 litres
   Jaggery 1.5 - 2.0 kg
   Gram flour 1.5 - 2.0 kg
   Water 180 litres
   Soil collected from area under the large canopy trees added as a native microflora inoculant 500 g

To prepare jeevamrut, the ingredients are mixed in a 200-liter drum, stirred twice daily in a clockwise direction, and left to ferment for 48 hours in a shaded area. During fermentation, aerobic and anaerobic bacteria from cow dung and urine actively multiply and decompose the organic matter. Cane jaggery acts as an energy source for microbes to enhance fermentation, while pulse flour supplies protein energy. In summer, jeevamrut is ready within 3–4 days, while in winter, it requires 6–7 days to complete the fermentation process.

2. Soil Application of jeevamrut : For application, jeevamrut should be used at the rate of 400 liters per acre during each irrigation cycle. For better efficiency and uniform application, jeevamrut can also be atomized through sprinkler or drip irrigation systems. This ensures optimal coverage and maximizes its beneficial effects. Adequate soil moisture is crucial when applying jeevamrut. The canopy region (i.e., the shaded region of a tree at noon) should be sprayed once or twice a month in a circular pattern.

3. For crops with a duration of 60 to 90 days
   - First spray: Mix 5 litres of filtered jeevamrut with 100 litres of water per acre and spray 21 days after sowing.
   - Second spray: Mix 20 litres of filtered jeevamrut with 200 litres of water per acre and spray it 21 days after first spraying.
   - Third spray: Mix 5 litres of sour buttermilk or lassi with 200 litres of water per acre and spray it 21 days after the second spraying.

4. For crops with a duration of 90 to 120 days
   - First spray: Mix 50 litres of filtered jeevamrut with 100 litres of water per acre and spray it 21 days after sowing.
   - Second spray: Mix 10 litres of filtered jeevamrut with 150 litres of water per acre and spray it 21 days after first spraying.
   - Third spray: Mix 20 litres of jeevamrut with 200 litres of water per acre and spray it 21 days after the second spraying.
   - Fourth and last spray: Mix 5 litres of sour buttermilk or 2 litres of coconut water with 200 litres of water per acre and spray it at the milking stage of growing or fruit initiation stage of the crop.

5. For crops with a duration of 120 to 135 days
   - First spray: Mix 5 litres of filtered jeevamrut with 200 litres of water per acre and spray it one month after sowing.
   - Second spray: Mix 10 litres of filtered jeevamrut with 150 litres of water per acre and spray it 21 days after first spraying.
   - Third spray: Mix 5 litres of sour buttermilk or lassi with 200 litres of water per acre and spray it 21 days after the second spraying.
   - Fourth spray: Mix 20 litres of filtered jeevamrut with 200 litres of water per acre and spray it 21 days after the third spraying.
   - Fifth and last spraying: Mix 5 litres of sour buttermilk or 2 litres of coconut water with 200 litres of water per acre and spray it at the milking stage of growing or fruit initiation stage of the crop.

6. For crops with a duration of 135 to 150 days
   - First spray: Mix 5 litres of filtered jeevamrut with 100 litres of water per acre and spray it a month after sowing.
   - Second spray: Mix 10 litres of filtered jeevamrut with 150 litres of water per acre and spray it 21 days after first spraying.
   - Third spray: Mix 5 litres of sour buttermilk or lassi with 200 litres of water per acre and spray it 21 days after the second spraying.
   - Fourth spray: Mix 20 litres of filtered jeevamrut with 200 litres of water per acre and spray it 21 days after the third spraying.
   - Fifth spray: Mix 20 litres of filtered jeevamrut with 200 litres of water per acre and spray it 21 days after the fourth spraying.
   - Last spraying: Mix 5 litres of sour buttermilk or 2 litres of coconut water with 200 litres of water per acre and spray it at the milking stage of growing or fruit initiation stage of the crop.

7. For crops with a duration of 165 to 180 days
   - First spray: Mix 5 litres of filtered jeevamrut with 150 litres of water per acre and spray it a month after sowing.
   - Second spray: Mix 10 litres of filtered jeevamrut with 150 litres of water per acre and spray it 21 days after first spraying.
   - Third spray: Mix 5 litres of sour buttermilk or lassi with 200 litres of water per acre and spray it 21 days after the second spraying.
   - Fourth spray: Mix 20 litres of filtered jeevamrut with 200 litres of water per acre and spray it 21 days after the third spraying.
   - Fifth spray: Mix 20 litres of filtered jeevamrut with 200 litres of water per acre and spray it 21 days after the fourth spraying.
   - Last spraying: Mix 20 litres of filtered jeevamrut with 200 litres of water per acre and spray it at the milking stage of growing or fruit initiation stage of the crop

8. Spraying jeevamrut on Sugarcane, Banana, and Papaya

Spray as per the method directed above for the first five months after sowing or planting these crops. Then, every 15 days, spray a mixture of 20 litres of jeevamrut with 200 litres of water per acre in sugarcane, banana and papaya.

9. Spraying of jeevamrut on fruit crops
   - Spray jeevamrut twice a month on the fruiting trees (of any age). Spray the fruit crops
   - with a mixture of 20-30 litres of filtered jeevamrut with 200 litres of water.
   - Spray a mixture of coconut water and 2 litres of water 2 months before fruit maturity.
   - After 15 days, spray a mixture of sour buttermilk with 200 litres of water.

iv. Preparation of ghan jeevamrut

- To prepare ghan jeevamrut, start by making a bed of dried cow dung, one and a half feet high and three feet wide, with the length as per requirement. Using a stick with a 1.5-inch diameter, create holes one foot above the bed in a zigzag pattern, spaced one foot apart.
- Fill these holes with fully prepared jeevamrut, allowing it to spread into the bed naturally.
- Leave the bed undisturbed for seven days.
- After seven days, shovel the mixture and reshape it into a bed in the same manner. Again, create holes at one-foot intervals and fill them with jeevamrut. Let this new bed ripen for another seven days. At the end of this process, the ghan jeevamrut will be ready for use.

- Ensure the bed is kept away from direct sunlight and rainwater during preparation. If you plan to store ghan jeevamrut, dry it thoroughly in strong sunlight and then store it in a dry place using a jute bag.

V. Soil Application of ghan jeevamrut

1. For soil application, ghan jeevamrut should be applied at the rate of 1000 kg per acre. This should be done before every plantation or at the beginning of each cropping season.

VI. Crop residues vary in composition and decomposition rates based on their Carbon-to-Nitrogen (C: N) ratio.

- High C: N ratio residues, like maize and wheat, decompose slowly, providing long-term soil organic matter and reducing erosion.
- Low C: N ratio residues, like soybean and legume crops, decompose quickly, enriching the soil with nitrogen and boosting microbial activity.
- Oilseed residues moderately improve soil texture and fertility, while soft residues from vegetables offer rapid nutrient cycling.
- Apply a thick layer of mulch around plants but not more than 4-6 inches. Ensure proper coverage to prevent moisture loss and weed growth.
- Cover crops or perennial and green manure crops keep the soil covered during the summer and other periods of time reducing the risk of erosion, compaction and Recapture excess nutrients. The biomass produced by cover crops is usually returned to the soil, enhancing organic matter levels.

VII. Cover Crops Grown for Specific Purposes :

Organic matter (high C:N)	Sorghum-Sudan grass, cereal rye, annual ryegrass, triticale, oats, wheat, spelt, barley,
Nitrogen (low C:N)	Cowpea, winter pea, red clover, sweet clover, alfalfa, soybeans, mung beans
Reduce soil compaction (deep rooted)	Sorghum-sudangrass, annual ryegrass, oilseed or tillage, radish, sweet clover-deep taproot, cereal rye, oats

Forage or can be grazed	Oats, forage radishes, turnips, cereal rye, annual ryegrass, teff for dry fields, sorghum-sudangrass, barley
Prevent soil erosion	Grasses have fibrous root systems to bind soil, and the best grass cover crops include cereal rye, annual ryegrass, oats, wheat, and barley. Other cover crops include buckwheat with a shallow fibrous root system, cowpea, winter pea
Recapture excess nutrients (nitrogen, phosphorus)	Oilseed or tillage radish, turnips, annual ryegrass, cereal rye, oats, wheat, sorghum-sudangrass, and buckwheat, sweet clover, winter pea, cowpea, red clover, hairy vetch
Tolerate wet soils	Sweet clover, red clover, annual ryegrass, cereal rye, wheat, and oats
Tolerate heat and drought	Cowpea, mung beans, sweet clover, sorghum sudan grass, buckwheat, barley
Attract beneficial insects	Buckwheat, sweet clover, red clover
Cold tolerant	Cereal rye, wheat, spelt, triticale, winter pea, and sweet clover
Natural herbicides or allelopathic effects for weed suppression	Cereal rye, oilseed or tillage radish, mustard, oats, barley, Buck wheat, and sorghum-sudangrass. Annual ryegrass, cereal rye, sorghum-sudangrass may be used for controlling soybean cyst nematodes.

VIII. Pre-season Dry Sowing

To maintain year-round green cover (365DGC) and active microbial activity by cultivating diversified crops during the off-season while reducing dependence on chemical inputs.

Pre-season Dry Sowing Implementation Process

a. Seed Composition and Preparation:
Use a seed kit containing 30-35 types of seeds (Cereals, Pulses, Millets, Oilseeds, Spices, Vegetables, etc.), 12-13 kg per acre. Pelletize seeds before sowing to improve germination. Seed compositions are customized for each district based on seed availability.

b. Time of Sowing: Broadcast seeds one week before the harvest of the preceding crop. Use residual moisture from Rainfed black soil (one week before harvest) and Irrigated systems (one week before harvest).

c. Sowing Method: Broadcast seeds evenly over the field during the harvest of the main crop. Provide a 1-2-inch layer of mulch using groundnut shells, crop residues, or paddy straw (less preferable).

d. Management Post-Sowing: Offseason rains support seed germination and growth. If plants survive beyond 25 days, microbial benefits accrue. Provide life-saving irrigation where possible.

e. Incorporation into Soil: Incorporate dry sowing crop foliage directly into the soil 7-10 days before sowing the main crop.

f. Utilization as Fodder: Use PMDS crop foliage as cattle fodder, leaving roots to enrich the soil.

g. Soil and Crop Health: Enhanced root-to-shoot ratio (PMDS: 0.312 vs. Chemical: 0.242). Improved soil carbon content and microbial activity. Resistance to lodging in heavy rains.

4. Crop diversification is essential to enhance ecological balance, improve resource utilization, and support sustainable farming practices. Follow the guidelines below to
implement effective crop diversification:

I. If the main crop is a monocot, the mixed/allied crop should be a dicot.
II. If the main crop is deep rooted, then shallow rooted mixed/allied crop should be selected.
III. The growing duration of a mixed/allied crop should be less than half or one-third of the main crop. That means, it should be ready in less time than the main crop.
IV. The shadow of mixed/allied crops should not fall on the leaves of main crop.

V. Mixed/allied crops should proliferate and cover the soil thoroughly like cucumber, watermelon etc.
VI. If the leaves of the main crop can tolerate intense sunlight, then mixed/allied crops that do not require intense sunlight should be planted.
VII. If the primary crop grows quickly, select a mixed/allied crop that grows slower than the main crop.

B. Nutrient management practices

i. Name of the practice: Plants meet their nutrient requirements from different sources. Natural biomass can also serve as a source of nutrient for crop plants and can be used after appropriate treatment or conversion, and in some cases even in raw form.

1. jeevamrut and ghan jeevamrut
2. Saptadhanyaankur ark
3. Residue Mulching
4. Permanent (365 Days) Soil Cover/ Pre-Season Dry Sowing/Manuring
5. Crop Diversification

ii. Brief description of the practice:

1. jeevamrut and ghan jeevamrut are fundamental to natural farming, enhancing soil health and nutrient availability through microbial enrichment and organic matter decomposition. These inputs introduce beneficial microorganisms that convert complex organic compounds into plant-available nutrients, fostering natural nutrient cycling. By improving soil structure, aeration, and water retention, they support root development and efficient nutrient uptake. The organic acids and enzymes produced by microbes enhance the solubility of essential nutrients like phosphorus, zinc, and iron, often locked in inaccessible forms.

2. Mulching plays a critical role in nutrient management by enhancing soil health and ensuring the efficient cycling of nutrients. By covering the soil with organic materials like crop residues, straw, or leaves, mulching creates a microclimate that promotes microbial activity and decomposition. This process releases nutrients such as nitrogen, phosphorus, and potassium into the soil in plant-available forms. Mulching also minimizes nutrient loss and facilitates better nutrient uptake by roots. Additionally, it suppresses weeds, reducing competition for nutrients, and improves soil organic carbon, which enhances nutrient retention and availability over time. This natural farming practice aligns with sustainable nutrient management, fostering a self-reliant and fertile soil ecosystem.

The combined use of bio-inputs such as jeevamrut and ghan jeevamrut , along with mulching, significantly enhances the activity of earthworms in the surface soil. Earthworm activity is stimulated by the favourable environment created by bio-inputs, which promote microbial growth, and by mulching, which maintains moisture and provides organic matter as food. Earthworm faeces, or castings, contain nutrient concentrations that are five times higher in nitrogen, nine times higher in phosphorus, and eleven times higher in potassium compared to the surrounding soil.

3. Growing and incorporation of tender biomass of legume crops in soil is known as ‘green manuring’. These crop plants fix atmospheric nitrogen, and after decomposition and incorporation, release this nitrogen into the soil, which helps improve its physical and biological properties. (Permanent Soil Cover/ Pre-Season Dry Sowing/Crop Diversification as per above practice A)

4. Saptadhanyaankur (Seven-Grain Sprouts) refers to a traditional preparation in Indian agriculture and natural farming practices that involves sprouting seeds of seven types of grains or cereals. These grains are often chosen for their nutrient content, potential to promote soil health, and cultural significance. The sprouted grains are used as a bio-activator in natural farming, especially for soil enrichment

iii. Benefits of the practices (impacts)

1. (jeevamrut, ghan jeevamrut , Residue Mulching, Permanent (365 Days) Soil Cover/ Pre- Season Dry Sowing and Crop Diversification as per above Practice A)

2. Saptadhanyaankur provides plants with nutrients & other growth promoters. Spraying will increase the shine on fruits, vegetables and grains.

iv. Protocols to be followed:

1. (jeevamrut, ghan jeevamrut , Residue Mulching, Permanent (365 Days) Soil Cover/ Pre- Season Dry Sowing and Crop Diversification as per above Practice A)

2. Preparation of Saptadhanyaankur

Sesame seeds 100 g
Mung bean seeds 100 g
Urdbean seeds 100 g
Cowpea (Lobia) seeds 100 g
Moth seeds 100 g
Chickpeas (Chana) seeds 100 g

7 wheat seeds 100 g

In a small bowl, take 100 grams of sesame seeds and add enough water to soak all the seeds and keep it in the shade. After two days, take a large bowl and put 100 grams of whole grain seeds of green gram (mung bean) 100 grams of black gram (urad), 100 grams of cowpeas beans, 100 grams of moth beans, 100 grams of chickpeas, and 100 grams of wheat grains.

Mix all these well and add enough water to soak them well. Then keep it indoors. After three days take out all the seeds, tie them in a cloth bag and keep them inside the house for germination. Also cover the water in which the grains were soaked. Open the bag when 1 cm long plumules (ankur) come out, then make its paste. Mix the paste in 200 litres of water by hand and also mix the previously steeped water. Leave this prepared mixture for 2 hours. After two hours, shake the mixture and strain it through a cloth.

Saptadhanyaankur ark Usage: The solution should be sprayed on the plants as a foliar spray at the rate of 200 L/Acre. This mixture should be sprayed within 48 hours of preparation without mixing with the water.

a. Spray on the vegetable crops (kharif or rabi) when the vegetables are in milking stage.
b. Spray on fruit trees when the fruits are small, medium or before they mature.
c. When the fruit pods are small.
d. In flower crops when the flowers are in the budding stage.

A. Plant protection practices

i. Name of the practice :

1. beejamrut
2. Dasparni Ark
3. Neemastra
4. Brahmastra
5. Agniastra
6. Sour Buttermilk
7. Mixed cropping (Push Pull System)
8. Trap crops

ii. Brief description of the practice:

1. Majority of the diseases and insect-pest infestation in the plants are seed and soil-borne. Beejamrut is a natural formulation to treat seeds, seedlings or other planting material before sowing to prevent seed and soil-borne diseases and insect-pest infestation.

2. Dasparni Ark is a botanical-based bio-formulation used in natural farming made from the leaves of ten different plant species, that is why it is called Dashparni Ark. It helps control pests, specifically all kinds of sucking pests and caterpillars. This formulation is made from neem leaves, karanj leaves, castor leaves, belpatra leaves, mango leaves, dhatura leaves, basil leaves, guava leaves, desi bitter gourd leaves, papaya leaves, turmeric leaves, ginger leaves, acacia leaves, custard apple leaves, along with ginger powder, turmeric powder, ginger paste, asafetida powder, chewing tobacco powder, spicy chili paste and garlic paste.

3. Neemastra is a natural pesticide used in natural farming practices, made primarily from Neem leaves. It is prepared by soaking Neem leaves in water for a specific period, sometimes combined with other ingredients like garlic or chili paste, to enhance its pest-repelling properties. Neemastra is highly effective in controlling a wide range of pests, especially insects like aphids, whiteflies, ants and caterpillars, while being safe for beneficial organisms and the environment. It works by disrupting the pests' feeding and reproductive cycles, making it a sustainable alternative to chemical pesticides.

4. Brahmastra is a natural biopesticide used in natural farming practices, to control large caterpillars and many other types of pest. It is prepared using a combination of medicinal plants such as neem, karanj, cilantro, bael, castor and dhatura leaves along with other ingredients like cow urine and water, all known for their antimicrobial and insecticidal properties.

5. Agniastra is a natural biopesticide used in natural farming systems, to control harmful pests and diseases. It is prepared by soaking a mixture of ingredients such as spicy green chili paste, garlic, crushed neem leaves and chewing tobacco often combined with cow urine to enhance its potency. Agniastra is effective in repelling and controlling a wide range of pests, including large sized insect pests, boring holes on leaves and living inside fruits. It works by acting as a strong irritant to pests, deterring them from feeding on plants, while being safe for beneficial organisms.

6. Sour buttermilk is used in natural farming formulations, particularly for disease control, due to its beneficial properties. It acts as a natural fungicide and helps in reducing the spread of harmful pathogens, making it an effective and eco-friendly alternative to chemical treatments in natural farming systems.

7. Mixed cropping systems are principal strategies among cultural practices to be followed for ecological pest management. It is mainly based on the principle of agro ecosystem diversity for pest and disease management, wherein two or more crops are raised simultaneously. In the push-pull mix cropping systems, specifically identified companion crop plants are raised in the field.

8. Trap crops: Trap crops are plants raised to entice insects away from the main crop.

ii Benefits of the practices (impacts):

1. Most of the diseases, insect-pest infestation and other disorders in plants are seed and soil-borne. So, it is important to treat seeds, seedlings or other planting material with beejamrut before sowing to prevent seed and soil-borne diseases and insect-pest infestation in plants

a. Use of beejamrut increase germination capacity of seeds.
b. It leads to uniform growth of seedlings and faster development of roots.
c. Plants remain free from seed and soil borne diseases, insect-pests and other disorders.

2. Dasparni Ark is a powerful botanical bio-formulation used in natural farming. It effectively controls a wide range of pests, especially sucking pests like aphids, whiteflies, and mealybugs, as well as caterpillars. Safe for humans, animals, and beneficial organisms, Dasparni Ark is a non-toxic, sustainable solution for pest management in natural farming.

3. Neemastra is widely used in natural farming for pest control, particularly effective against a range of insect pests like aphids, whiteflies, and caterpillars. Made primarily from Neem leaves, it works by disrupting the pests feeding and reproductive cycles, acting as both a repellant and a growth regulator. Neemastra is eco-friendly, non-toxic to humans, animals, and beneficial insects. It enhances plant health by reducing pest damage.

4. Brahmastra is effectively controlling large caterpillars and many other types of pests. It is an eco-friendly alternative to chemical pesticides, it is safe for humans, animals, and beneficial organisms, supporting biodiversity and reducing environmental harm.

5. Agniastra is a natural bio-pesticide made from ingredients like chili, garlic, and ginger, known for their strong pest-repelling properties. It effectively controls a wide range of pests, especially sucking insects like aphids and whiteflies, as well as fungal infections.

As an eco-friendly solution, Agniastra is safe for humans, animals, and beneficial insects. It helps reduce pest damage. It controls the large sized insect pests boring holes on leaves and living inside fruits.

6. Sour buttermilk offers several benefits in natural farming. It contains lactic acid bacteria (LAB) that possess antifungal and antibacterial properties, making it effective in controlling plant diseases like fungal infections and bacterial blight. The organic acids, enzymes, and beneficial microorganisms found in sour buttermilk promote soil health, enhance microbial activity, and stimulate plant growth. As a natural fungicide, it helps reduce the spread of harmful pathogens.

7. Mixed cropping (Push Pull System): In the push-pull intercropping systems, specifically identified companion crop plants are raised in between the main crop, which acts as a push component, and the pull components are plated as borders. The ‘push’ component in this system repels the insects (using semiochemicals), whereas the ‘pull' component, i.e., the trap-crop, attracts the pest species away from the main crop.

8. Trap crops are plants raised to entice insects away from the main crop. While selecting a trap crop, care must be taken that the trap crop species must be more attractive to the insect pests than the main crop and in no case, the pest should migrate from the trap crop to the main crop. Hence, effective utilization of trap crop technology is a challenging strategy that needs a thorough understanding of the food preference behaviour of pests.

(iv) Protocols to be followed:

1. Preparation of beejamrut

Cow urine 05 litres
Cow dung 05 kg
Lime 50 g
Soil collected from area under the large canopy trees added as a native microflora inoculant 500 g
5 Water 20 Liter

Mix the above ingredients and keep it overnight. Treat the seed or planting material before sowing with 200 ml beejamrut per kg seed. Spread the seeds overnight to dry. In case of vegetative propagating crops, put tubers/rhizomes/sets/grafts of selected crop in a bamboo basket and dip the basket in a tub containing beejamrut for 15-20 seconds for treatment. Dry the seeds in shade and use them for sowing the next day.

2. Preparation of Dasparni Ark

Water 200 liters, Belpatra leaves 2 kg, Cow urine 10 liters , Mango leaves 2 kg, Cow dung 2 kg , Dhatura leaves 2 kg, Turmeric powder 500 g , Basil leaves 2 kg, Ginger paste 500g , Guava leaves 2 kg, Asafetida powder 10 g , Desi bitter gourd leaves 2 kg, Chewing tobacco powder 1 kg , Papaya leaves 2 kg, Spicy chili paste 1 kg , Turmeric leaves 2 kg, Garlic paste 500 g , Ginger leaves 2 kg, Neem leaves 2 kg , Acacia leaves 2 kg, Karanj leaves 2 kg , Custard apple leaves 2 kg, Castor leaves 2 kg , Ginger powder 200 g

Note: Any 10 of the above-mentioned plant parts can be added. The first five are important. Put all the above-mentioned plant parts, dung and urine in a barrel and stir clockwise with a stick twice a day i.e., morning and evening. Keep this mixture in shade and protect it from water as well as sunlight. Leave the mixture for 40 days to be ready and then filter it with a cloth. Filtered Dasparni Ark can be stored for 6 months.

Spray: Mix 500-600 mL of Dasparni Ark with 15 liters of water and sprayed during pest infestation

3. Preparation of Neemastra

Neem leaves and crushed seed kernel 5 kg, Cow urine 5 litre, Cow dung 1 kg, 4 Water 100 litres. Mix above mentioned ingredients in a barrel and keep for 48 hours. Stir with a stick thrice a day and filter through a cloth before spraying. Spray 200 L Neemastra/ Acre during insect infestation

4. Preparation of Brahmastra

Cow urine 10 litres, Neem leaves 3 kg, Karanj leaves 2 kg, Cilantro leaves 2 kg, Bael leaves 2 kg, Castor leaves 2 kg, Dhatura leaves 2 kg

To make Brahmastra, select any of the above five ingredients. Grind all the leaves together. Put this mixture in an earthen pot and boil it with 20 liters of water. When four boils come, take it off and keep it in the shade for two to three days to cool down. After this, mix cow urine in it and filter it with a cloth and keep it in an earthen pot to store. It is important to protect it from the direct sunlight.

Spray: Mix 500 mL Brahmastra with 15 L of water and sprayed during insect infestation

5. Preparation of Agniastra

Cow urine 10 litres, Spicy green chilli paste 500 g, Garlic paste 500 g, Crushed neem leaves 5 kg, Chewing tobacco 1 kg

Mix above mentioned ingredients and boil it until four boils than cool the mixture for 48 hours. Mix 2-3 litres in a day and after then filter it with a cloth which can store for 3 Months.

Spray: Mix 500 mL Agniastra with 15 L of water and sprayed during insect infestation

6. Preparation of Sour buttermilk
Water 100 litres, Sour buttermilk 3 litres
Mix both together in the above-mentioned ratio and spray as an effective fungicide.

D. Weed Management in Natural Farming

i. Name of Practices
1. Mulching
2. Mixed cropping
3. Crop diversification
4. Cover crop
5. Water management
6. Use of Weed Free Seeds

ii. Brief Description of the practice

1. Mulching: Mulching or covering the soil surface can prevent weed seed germination by blocking light transmission preventing seed germination. Mulches physically suppress weed seeds emergence. There are many forms of mulches available. The following two are suitable practices of mulching in natural farming:

- Living mulch/Organic mulch: Living mulch is usually a plant species that grows densely and low to the ground such as clover. Living mulches can be planted before or after a crop is established. It is important to kill ad till in, or manage living mulch so that it does not compete with the actual crop. Often, the primary purpose of living mulch is to improve soil structure, aid fertility or reduce pest problems and weed suppression may be merely an added benefit.
- Soil mulch: Mulching with soil involves creating a protective layer of soil around plants or over the soil surface to mimic natural processes and provide benefits similar to conventional mulching methods. This practice is particularly suited to regions with limited access to organic mulch materials or in areas where soil conservation is essential.
- Plant residue mulching (Mulching with plant/crop residue): Plant residue mulching involves using leftover parts of crops or vegetation (e.g., straw, stalks, leaves, or husks) as a protective layer on the soil surface. It is a highly sustainable and cost-effective practice in natural farming that enhances soil fertility and reduces reliance on external inputs.

2. Mixed Cropping: Mixed cropping is an age-old agricultural practice of cultivating two or more crops simultaneously on the same piece of land. In natural farming, this method

aligns with the principles of ecological balance, biodiversity conservation, and low-input farming. By leveraging the natural symbiotic relationships between crops, mixed cropping ensures sustainable agricultural productivity without relying on synthetic inputs.

3. Crop diversification: Crop diversification in natural farming is a sustainable approach that fosters ecosystem health, optimizes resource use, and improves farm resilience. It enhances productivity while reducing the environmental footprint, making it a key practice in achieving long-term agricultural sustainability.

4. Cover crop: Plants grown primarily to cover the soil rather than for harvest. In natural farming, cover crops are an essential practice for enhancing soil health, managing weeds, and promoting sustainable agricultural systems. They are typically planted during the off-season or between primary crop cycles to provide multiple ecological and agronomic benefits.

5. Water management: Effective water management is a crucial component of weed control in natural farming. Water influences weed growth directly by affecting seed germination, plant establishment, and competition between weeds and crops. By managing water efficiently, farmers can reduce weed populations and create a more favorable environment for desired crops.

6. Use weed free seeds: The use of weed-free seeds is an important practice in natural farming to prevent the introduction and spread of weed species on a farm. By selecting seeds that are free from weed contamination, farmers can reduce the need for chemical herbicides and minimize the risk of invasive weed species that could damage crops or decrease yields.

iii. Benefits of the practice (impact):

1. Mulch creates a physical barrier by covering the soil surface. This will block sunlight from reaching weed seeds. This inhibits germination and growth, reducing weed emergence. Thick mulch layer will cover small or emerging weeds, suffocating them and preventing further growth of weed. Organic mulches like plant residues or grass clippings fill available gaps in the soil, leaving less space for weeds to establish. Mulching minimizing weed seed dispersion by preventing the weed seeds from being blown onto the soil or carried by water, reducing the weed seed bank in the field. Consistent moisture under mulch discourages certain weeds that thrive in dry conditions. Mulching stabilizes soil temperature, which can prevent the germination of weeds adapted to temperature fluctuations.

2. Mixed cropping systems combine crops with different growth patterns (e.g., tall and spreading) to create a dense canopy that shades the soil. This limits the sunlight available for weed germination and growth. Example: Maize and cowpea, where maize provides vertical growth and cowpea spreads across the ground. Mixed crops efficiently utilize nutrients, leaving fewer resources available for weeds.

Crops with varied rooting depths exploit water resources differently, depriving weeds of moisture. The combined root systems of mixed crops occupy soil niches, preventing weeds from establishing. Some crops release allelochemicals (natural compounds) through roots or residues that inhibit weed seed germination and growth.

Example: Mustard and sorghum have allelopathic properties that suppress weeds. Crop residues left after harvest in a mixed cropping system can act as a natural mulch, suppressing weeds for subsequent crops. The diversity of crops disrupts the lifecycle of specific weed species by altering soil conditions and reducing their preferred growing environment. Growing different family crops in mixed cropping will break the cycle of infestation and change the microclimate which will affect the germination and viability of the weed seed.

3. Diverse crops use different amounts of sunlight, water, and nutrients, which limits the availability of these resources for weeds. For instance, tall crops like maize may shade the soil, while ground-hugging crops like legumes spread to cover the soil and block weed growth. Example: Intercropping maize with beans or cowpeas, where beans help cover the ground, leaving less space for weeds to grow. Diverse crops planted together create a dense canopy that shades the soil and prevents sunlight from reaching weed seeds. This inhibits germination and growth of weeds that rely on sunlight to thrive.

Example: In intercropping systems like maize and pigeon peas, maize forms a tall canopy, and the peas spread across the ground, blocking sunlight for weeds.

Some crops naturally release chemicals (allelochemicals) through their roots, leaves, or decaying residues that inhibit weed seed germination or growth. This natural herbicidal action can help control weeds in diversified systems. Example: Mustard, sorghum, and sunflower are known for their allelopathic properties, which can suppress weeds when used in intercropping or rotation.

By alternating different crops each season, farmers can break the lifecycle of weeds that are adapted to a particular crop. This reduces the chance of weeds becoming resistant to a particular crop or cultivation practice. Example: Rotating between wheat,

legumes, and vegetables disrupts the growth cycles of weeds that are common in monoculture systems. Different crops have varying root depths, types, and structures. This diversity means that crops use different parts of the soil, leaving less room for weeds to establish themselves. Shallow-rooted crops may help suppress deep-rooted weeds, while deeper-rooted crops can outcompete weeds that grow near the surface.

Example: Planting legumes (shallow roots) with deep-rooted crops like maize or sunflowers can improve soil structure and reduce weed competition. In diversified systems, especially with perennials and cover crops, the soil is less disturbed, creating conditions where weed seeds may not be exposed to light or favorable conditions for germination. Example: Cover crops in a rotation system can suppress weeds by maintaining continuous ground cover, reducing the need for tillage that brings weed seeds to the surface.

4. Weed Suppression can be achieved as cover crops grow rapidly and form dense canopies that shade the soil, preventing sunlight from reaching weed seeds, thus inhibiting their germination and growth.

Cover crops, like legumes, grasses, or broadleaves, compete with weeds for essential resources such as water, nutrients, and space. This competition weakens the weeds and limits their growth potential. Some cover crops, such as mustard or sunflower, release natural chemicals (allelopathic compounds) into the soil that can inhibit weed seed germination and growth. These chemicals can affect the growth of nearby plants, including weeds. The roots of cover crops, especially deep-rooted ones like radish , can physically disturb the soil, making it harder for weeds to establish their root systems. Additionally, cover crops help to break up soil compaction, allowing for better root penetration by desirable plants.

When cover crops are mowed or left to decompose on the soil surface, they act as a mulch, creating a thick layer that prevents weeds from emerging. The decaying matter also adds organic matter to the soil, enriching it and enhancing soil health. By rotating cover crops regularly (e.g., planting different species each season), farmers disrupt the growth patterns of weeds that are adapted to specific crops. This rotation prevents weeds from becoming accustomed to a particular cropping system. Continuous cropping with the same species can promote specific weed species; cover crops in rotation break this cycle, reducing weed pressure over time.

5. Irrigating at the right time can prevent weeds from germinating. For example, delaying irrigation until after the crop has emerged can help reduce weed seed germination, as weeds often need water to sprout. Conversely, avoiding over-irrigation

reduces the excess moisture that promotes weed growth. Drip or localized irrigation minimizes the moisture available to weeds that grow between crops, while promoting healthy growth for crops that need water. This system reduces weed germination between the rows or in areas where crops are not planted.

By maintaining the right moisture level, crops can develop deeper, stronger root systems, making them more competitive with weeds. Conversely, weeds are often shallow-rooted and sensitive to fluctuations in moisture. Maintaining optimal soil moisture encourages crops to grow vigorously while limiting the growth of weeds. In natural farming a dry period can prevent many weeds from germinating by inhibiting their growth cycle. Wetting and drying cycles can be managed by alternating irrigation and avoiding unnecessary moisture in between crop growing seasons, particularly during the early stages of weed germination. By watering during the early stages of crop growth and after weed emergence, crops establish strong root systems and reduce the chance of weeds becoming established. Conversely, avoiding irrigation right before or during peak weed germination can limit weed growth.

Combining water management with mulching techniques can provide additional weed control benefits. Mulch reduces soil evaporation, moderates temperature, and provides a physical barrier for weed seeds. In some natural farming systems, controlled wetland or shallow water systems can be used to control invasive weeds. Weeds that thrive in wet conditions, such as water hyacinth or duckweed, can be controlled by regulating water levels. Creating an environment that supports crops while limiting weeds' ability to grow can improve both yield and weed control.

6. Weeds often spread through contaminated seeds. By using weed-free seeds, farmers reduce the risk of introducing new weed species to their fields, which can otherwise become a major source of weed pressure and competition for resources. The seed bank in the soil can be replenished with weed seeds, which may persist for years, making weed management harder in subsequent seasons. When weed-free seeds are used, crops have a better chance to grow without competing for water, light, and nutrients with unwanted weeds. This can lead to improved crop yields and healthier plants, as they do not have to struggle with weed competition. By consistently using weed-free seeds, farmers can prevent the establishment of new weed populations in their fields, ultimately reducing the weed seed bank in the soil and decreasing the need for frequent weeding.

iv. Protocol to be followed:

1. Remove large weeds manually or through shallow tillage to prepare the field. Crop residues like straw, husks, or leaves should ideally be by-products to minimize costs. The material should decompose naturally, enriching the soil with organic matter over time. Examples: Legumes (e.g., cowpea, mung bean), cereal residues (e.g., wheat or rice straw). Crops with dense residues that effectively block sunlight and inhibit weed growth. Example: Maize stalks or sugarcane leaves. Residues should not harbor pests or pathogens that could infect crops. Avoid using diseased crop residues. Ensure the selected crop residues do not release toxic compounds that could hinder the growth of the main crop. Example: Avoid walnut or eucalyptus leaves known for allelopathy. Crops producing substantial biomass are ideal for thick and uniform mulch layers. Examples: Sunflower stalks, sorghum, and pigeon pea residues. The crop residues should suit the local soil type and climatic conditions. Example: Grass clippings work well in tropical regions, while straw is effective in temperate climates. Residues from nutrient-rich crops can enhance soil fertility as they decompose. Example: Legume crops like groundnut or chickpea. Select crops that offer additional benefits, such as erosion control, moisture conservation, or fostering beneficial microorganisms. Example: Cover crops like clover or alfalfa. Apply a 5–10 cm thick layer of mulch for effective weed suppression and moisture conservation. Adjust thickness based on the material; finer materials require a thicker layer. Leave a small gap (3–5 cm) around plant stems to prevent rotting and pest attacks. Spread mulch evenly across the field to avoid patchy coverage.

2. Ensure crops have complementary growth habits and resource requirements. Use appropriate row ratios (e.g., 2:1 or 4:1) to maximize coverage. Synchronize sowing of mixed crops to establish a competitive advantage over weeds. Observe fields during the early stages to address weed emergence promptly. By growing crops with varying root depths, canopy structures, and growth habits, weeds have less opportunity to establish and compete for space, light, and nutrients. Growing a variety of crops attracts different pollinators, beneficial insects, and wildlife, which contribute to the health and balance of the farm ecosystem.

3. Understand soil type, climate, water availability, and pest pressure in the region. Select crops with complementary growth patterns (e.g., tall and short, deep-rooted and shallow-rooted). Ensuring crops have different nutrients, water, and sunlight needs to reduce direct competition among them and with weeds. Choose crops that have natural weed-suppressing properties (e.g., mustard, sorghum, and sunflower) for their allelopathic effects. Design a crop rotation system that alternates between legumes (e.g., chickpeas, lentils) and cereals (e.g., wheat, rice) to disrupt weed cycles and reduce weed seed buildup. Use appropriate crop density (e.g., 2:1 or 4:1) to ensure optimal canopy formation and soil cover. Choose crops with staggered maturity periods

to ensure that the soil remains covered with crops at different stages, limiting weed opportunities.

4. Choose cover crops that suit the local climate, soil conditions, and specific weed control needs. The cover crop can belong to the class of: Legumes (e.g., clover, vetch) are ideal for adding nitrogen to the soil while suppressing weeds through canopy growth. Grasses (e.g., rye, oats) are great for quick ground coverage and root competition, preventing weed growth. Brassicas (e.g., mustard, radish) can help suppress weeds via allelopathy (chemical release). Broadleaf plants (e.g., buckwheat) provide quick growth and smother weeds through dense foliage. Ensure the cover crop is planted at the right time to maximize weed suppression. Ensure cover crops are dense enough to effectively suppress weeds. Manage the growth of cover crops to maximize their weed-suppressing potential. Rotate different cover crop species to avoid weed species becoming adapted to a particular cover crop.

5. Use drip irrigation systems to directly apply water to the root zone of crops, reducing the water supply to surrounding areas where weeds may grow. Water crops according to their specific needs at different growth stages, ensuring that the soil is not overly saturated, which can encourage weed germination. Use soil moisture sensors or a simple feel test to determine the moisture content in the soil and adjust irrigation accordingly. Maintaining optimal soil moisture helps crops while minimizing conditions favorable for weed germination. Apply water in small, frequent amounts to maintain consistent moisture in the crop root zone without promoting excessive moisture on the soil surface, which can favor weed seed germination.
Ensure that the soil drains well and doesn't become waterlogged, as stagnant water encourages weed growth and may harm crops. Schedule irrigation to limit moisture availability for weeds, especially during their germination phase. Avoid irrigating immediately after weeding or tilling, as this could provide ideal conditions for weed seeds to germinate. Allow the soil to dry slightly before irrigation to prevent a flush of new weed growth. Weeds generally grow most vigorously during warm and moist conditions. Avoid excessive irrigation during this period to limit water availability to weeds. If possible, use rainwater harvesting systems to supplement irrigation, reducing the need for water that may contribute to runoff and weed spread. Before irrigating, manually remove or mulch weeds, as their competition for water will be higher once irrigation takes place. This ensures the crop benefits from water without excessive weed growth.

6. Choose good quality indigenous seeds for sowing. Before planting, carefully inspect the seeds for visible weed seeds or contaminants. If needed, clean the seeds manually using techniques such as:

- Sieving: Use fine sieves to remove small weed seeds and debris.
- Air Screening: Blow air over seeds to remove lighter weed seeds and chaff.
- Washing: Wash the seeds to remove dirt and contaminants.

Store seeds in clean, dry, and cool conditions to avoid recontamination. Ensure that storage containers are tightly sealed to prevent exposure to external contaminants. Store seeds in airtight containers to prevent contamination from external sources. Keep seeds in a cool, dry, and dark place to maintain seed quality and reduce the risk of contamination by mold, pests, or weeds. If storing large quantities, ensure that seed storage areas are cleaned regularly to avoid the buildup of debris or potential weed seeds. Ensure that the soil and growing environment are free from weed seeds. Remove any visible weeds in the soil using manual weeding or mechanical methods (such as tilling or hoeing) before planting.

By ensuring that seeds are free from weeds, practicing proper soil management, and using complementary techniques like mulching and crop rotation, farmers can effectively manage weed populations

E. Seed Selection, Treatment and sowing practices

i. Name of Practice:

- Use indigenous seeds
- Selection of healthy plants
- Mature seed harvesting
- Lunar calendar practices

ii. Brief Description of the practice:

1. Indigenous seeds refer to locally adapted, traditional varieties of seeds that have been passed down through generations and are well-suited to the local environmental conditions, soil types, and farming practices. In natural farming, the use of indigenous seeds is a fundamental practice for promoting sustainability, biodiversity, and resilience in agricultural ecosystems. These seeds are typically non-GMO, open-pollinated, and exhibit strong natural traits such as resistance to local pests, diseases, and climate stressors.

2. Seeds were collected from the healthiest and most productive plants. Farmers believed that seeds from robust plants would ensure a better yield.

3. Seeds were harvested only when fully mature to ensure high germination rates. The moisture content should be optimum will storage and it will affect the viability and storage quality of the seed.

4. The Lunar Calendar has been traditionally used in various cultures around the world to guide agricultural practices, including seed selection, planting, and harvesting. This system is based on the phases of the moon, which influence various natural processes such as soil moisture, plant growth, and pest behavior. In natural farming, lunar calendar practices are often used to determine the most auspicious times for seed selection, sowing, and other important farming activities to promote healthy crop growth and improve yields.

iii. Benefits of the practices:

1. The use of indigenous seeds is a cornerstone practice in natural farming that emphasizes sustainability, biodiversity, and resilience. Indigenous seeds, often referred to as traditional or native seeds, are those that have been cultivated and adapted to a particular region over generations. They are well-suited to local environmental conditions and play a critical role in ensuring ecological balance and reducing dependency on commercial seed systems.

2. In natural farming, selecting seeds from healthy plants is a fundamental practice that ensures the quality, viability, and resilience of the seeds used in subsequent planting cycles. This approach emphasizes the importance of choosing plants that have demonstrated robust growth, resistance to pests and diseases, and adaptation to the local environment. By prioritizing healthy plants, farmers can maintain biodiversity, improve crop productivity, and align with the principles of sustainability in natural farming. Plants that exhibit strong, uniform growth with sturdy stems, healthy foliage, and an absence of deformities.
Selecting seeds from high-yielding plants enhances productivity in subsequent planting cycles. Local adaptation ensures that the seeds are more resilient to environmental stressors like drought, heat, or flooding.

3. Harvesting mature seeds is a crucial practice in natural farming that ensures the selection of high-quality, viable seeds for the next planting cycle. These seeds are better suited for the local environment and help build a more sustainable farming system. Mature seeds have a higher germination rate compared to immature seeds. This is because they are fully developed and stored the necessary nutrients required for successful sprouting and initial growth. Seeds harvested at the right maturity stage tend

to produce healthier, more robust plants. These plants are better equipped to withstand environmental stresses like drought, pests, and diseases.

Harvesting seeds from plants that have thrived in the local environment ensures that the seeds are well-adapted to the soil, climate, and growing conditions By selecting seeds from a wide variety of plants and avoiding hybrid varieties, mature seed harvesting helps preserve genetic diversity within the farming system. Mature seeds are less prone to spoilage and have a longer shelf life than immature seeds. They are also more stable in terms of moisture content, making them easier to store.

4. During the new moon phase:

It is believed that the energy of the moon is inward and focused, which can promote seed germination and root growth. This phase is considered ideal for selecting and preparing seeds for sowing. Seeds are often soaked or treated during this time to enhance their viability. Some farmers believe that seeds planted at this time will grow stronger, as the moon's influence on the soil encourages deep root development.

The waxing moon occurs after the new moon: The moon increases in size toward the full moon. The waxing moon is associated with increasing light, which is believed to stimulate growth and development of above- ground plant parts, such as stems, leaves, and flowers. This phase is considered the best time for planting seeds that produce above-ground crops, such as leafy vegetables and fruits. It is believed that planting during this phase helps the plants establish stronger above-ground growth. Additionally, seeds that are more sensitive to light or heat may be chosen for planting during this time.

The full moon occurs when the moon is fully visible: The full moon phase is associated with a peak in energy and light. It is believed that the full moon encourages plant maturation and seed setting. This phase is considered ideal for harvesting mature crops that are ready for seed saving. Seeds collected during the full moon are believed to be more potent and have better germination rates. Additionally, this phase is associated with the collection of medicinal herbs and crops that need to be harvested at their peak vitality. The waning moon occurs after the full moon, as the moon decreases in size.

Impact on Seed Selection: The waning moon is believed to slow down plant growth and encourage the focus to shift below ground, improving root health and soil fertility. This is a good time for seed selection that requires less above-ground growth, such as root vegetables (carrots, potatoes, etc.) or perennials. It is also a phase for maintaining the soil, applying compost, and ensuring that the land is in good condition for future

planting. The waning moon is not typically considered an ideal time for planting seeds, but it's used for other important agricultural activities like weeding, soil preparation, and harvesting crops that are meant to be stored.

iv. Protocol to be followed:

1. Obtain seeds from community seed banks, traditional farmers, or indigenous knowledge holders. Use seeds saved from previous harvests of traditional varieties grown on the farm. Prevent cross-pollination by isolating indigenous varieties from other crops or hybrids during flowering. Regularly monitor fields to rogue out plants that do not conform to the desired characteristics. Dry seeds thoroughly after harvest to reduce moisture content and prevent spoilage. Store seeds in cool, dark, and pest-free conditions, using breathable containers such as cloth bags or clay pots. Conduct germination tests before planting to ensure seed viability. This can be done by sprouting a small sample in moist conditions and observing the germination rate.

2. Choose fields practicing natural farming methods to ensure the seeds are free from synthetic chemical contamination. Ensure the crop is grown under optimal natural farming practices, such as using Jeevamrut, mulching, and crop diversity. Choose plants that exhibit robust growth, strong stems, and healthy foliage. Avoid plants with signs of stunted growth or pest and disease damage. Choose plants with the highest yield potential. Reject plants showing symptoms of diseases, pest infestations, or physical injuries. Ensure that selected plants have not required external pest control measures, highlighting their natural resistance. Collect seeds at full maturity when the plant has dried or ripened naturally. Use clean and dry tools for harvesting and processing. Dry seeds thoroughly before storage to reduce moisture content and prevent spoilage. Store seeds in a cool, dry place using natural storage methods, such as neem leaves or ash, to prevent pest infestations.

3. Choose fields managed under natural farming practices, free from chemical inputs, and with healthy, pest-free plants. Prefer indigenous, locally adapted varieties that align with the agro-climatic zone. Reduced moisture content in seeds (generally below 20%). Drying of the surrounding plant parts like leaves and pods. Harvest during dry weather to minimize moisture absorption. Morning hours are preferred when seeds are not exposed to excessive heat but have started drying. Use sickles or clippers to cut mature plants or pods. Avoid shaking or rough handling to prevent seed shattering. Hand-pick the best seeds from robust, high-yielding plants to ensure quality. Spread seeds thinly on a clean surface (e.g., jute mats or bamboo trays) under shade to avoid direct sunlight, which can reduce seed viability. Ensure seeds reach the ideal moisture content for storage (8-12% for most crops). Remove chaff, dirt, and immature or damaged

seeds using sieves or hand sorting. Discard damaged or discolored seeds to prevent contamination. Use neem leaves, ash, or turmeric powder to deter pests and fungal growth.

4. Refer to a reliable lunar calendar to identify key phases. Align seed selection activities with specific phases based on crop type (e.g., above-ground crops during waxing/full moon, root crops during waning moon). Observe the crop during the chosen lunar phase for maturity indicators. Harvest seeds on days considered auspicious in the lunar calendar, avoiding days marked as inauspicious (e.g., eclipse periods). Dry seeds during the waning moon for optimal moisture reduction. Avoid direct sunlight during drying, especially during the full moon, to maintain seed vitality. Store seeds in natural materials like clay pots, neem-treated cloth bags, or bamboo containers. Label seeds with the harvest date and lunar phase for future reference. Test seed germination and vigor periodically to ensure quality.

Waxing Moon (Shukla Paksha): Select seeds from plants showing robust growth and productivity. Avoid seed selection during eclipses or adverse astrological timings.

F. Seed Treatment Practice

Name of Practice:

1. Beejamrut
2. Cow Urine (Gomutra)
3. Neem Leaf Extract
4. Turmeric Powder
5. Wood Ash Coating
6. Lime Treatment
7. Buttermilk
8. Salt Water Treatment

Brief description of the practice:

1. Beejamrut is a liquid formulation made from indigenous cow dung, cow urine, lime or quicklime, water and handful of arable filed soil. It is one of the main components of natural farming used for the seed treatment.

2. Cow urine is an important component used in natural farming.

3. Neem is having high herbal and medicinal value in our ancient heritage of the India. Different products made from the neem leaves are used for making bio-formulation like

Neemastra. When it comes to seed treatment, neem leave powder or extract can also be used for treating the seed in natural farming practice. Seeds are treated with neem leaf paste or decoction for protection from soil borne pathogens.

4. Turmeric power or paste have high herbal and medicinal value in our ancient heritage of the India. Different products made from the turmeric are used for giving seed treatment. Coating the seed with turmeric helps in protection from soil borne pathogens.

5. The ash collects from Agnihotra or simple ash for protecting the seed from the disease- causing microbes in the soil.

6. Lime (calcium hydroxide or calcium carbonate) is used for seed treatment in natural farming due to its beneficial properties that enhance seed health, germination, and early seedling vigor. It is used to treat the seed to prevent it from seed borne disease. Lime is also a constituent of beejamrut which is also used for seed treatment.

7. Buttermilk (a fermented dairy product) is a traditional and eco-friendly input used in natural farming for seed treatment. It is valued for its beneficial microbial content, nutrients, and ability to promote healthy seed germination and early plant growth.

8. Salt water is a simple, traditional method used in natural farming for seed treatment. It primarily serves as a seed quality test and as a pre-sowing treatment to enhance seed germination and protect against pests and diseases.

Benefits of the practices (impact)

1. Seed treatment with beejamrut germinate quickly and abundantly. Roots grow rapidly. Moreover, the plant can thrive well against soil-borne diseases and flourishes very well. beejamrut protects the crop from soil-borne and seed-borne pathogens and it improves seed germination also. Cow urine has anti-fungal properties and is also a good source of plant nutrients.

2. Cow urine has strong antimicrobial properties, effectively eliminating seed-borne pathogens such as fungi, bacteria, and viruses. Reduces the risk of early-stage diseases and promotes healthier crop establishment. The nutrients and enzymes in cow urine stimulate seed germination, leading to quicker and more uniform sprouting. Bioactive compounds in cow urine enhance the seeds' natural defense mechanisms, making plants more resistant to pests and diseases throughout their lifecycle. Cow urine encourages the growth of beneficial microorganisms in the seed's immediate

environment. These microbes help improve nutrient availability, such as nitrogen fixation and phosphorus solubilization, which support plant growth.

3. Neem leaves contain compounds like azadirachtin, nimbin, and nimbidin, which have strong antifungal and antibacterial properties. These compounds effectively combat seed-borne pathogens, reducing the incidence of fungal and bacterial infections. Neem leaves repel pests like nematodes, termites, and other insects that attack seeds during germination. The bitter taste and smell of neem deter insects, ensuring pest- free germination. Neem also prevents fungal growth during seed storage.

4. Turmeric contains curcumin, a bioactive compound with potent antifungal, antibacterial, and antiviral properties. It prevents seed-borne infections and reduces the risk of fungal diseases such as damping-off and root rot. Turmeric's strong aroma and bitter taste repel seed and soil-borne pests, preventing damage during germination and early growth.

5. Wood ash contains potassium salts and other alkaline compounds that act as a natural repellent against seed and soil-borne pests, such as ants, termites, and weevils. The ash coating creates a barrier that deters pests from damaging the seeds. The alkaline nature of wood ash inhibits the growth of fungi and bacteria on seeds, protecting them from seed-borne diseases like damping-off and root rot. The mineral content of wood ash, especially potassium, calcium, and trace elements, stimulates seed germination and improves early root development. Potassium is essential for seed vigor and germination efficiency.

6. Lime has strong antifungal and antibacterial properties, which help protect seeds from seed-borne pathogens. It reduces the incidence of diseases like seed rot, damping-off, and root rot. Lime is alkaline in nature and helps neutralize acidity in the seed's immediate environment. It creates favorable conditions for germination by reducing the effect of soil acidity, especially in acidic soils. Lime absorbs excess moisture from seeds, preventing fungal growth and spoilage during storage. This extends seed shelf life, especially in humid conditions.

7. Buttermilk is a natural source of lactic acid bacteria (LAB), which suppress harmful seed-borne pathogens such as fungi and bacteria. These beneficial microbes colonize the seed surface and act as a biological barrier against diseases like damping-off and root rot. The lactic acid in buttermilk creates an acidic environment, inhibiting the growth of harmful pathogens on the seed surface. This reduces the incidence of seed- borne fungal and bacterial diseases. Buttermilk contains essential nutrients like calcium, proteins, and vitamins that nourish the seed and promote better germination.

8. Salt water is used to separate viable seeds (good quality) from non-viable or damaged seeds. Viable seeds sink to the bottom, while non-viable, hollow, or infested seeds float due to their lower density. Salt water helps eliminate some seed-borne fungal spores, bacterial pathogens, and pests present on the seed surface. The treatment ensures that only healthy, viable seeds are selected for sowing, leading to improved germination rates and better crop establishment.

Protocol:

1. Mix 5 kg of indigenous cow dung, 5 liters of indigenous cow urine, 50 g lime or quicklime and one handful of arable filed soil mix them in 20 liters of water. Mix all of these ingredients in water and keep them a side for24 hours. Twice a day, stir the mixture with a wooden stick. After that, the seeds are treated with this mixture and dried in the shade before being planted. Dipping normal seeds for 6 – 7 hours and special seeds like bitter gourd (Karela) and Ivy gourd (Tinda) for 12 – 14 hours in beejamrut helps with the process. After that, strain beejamrut and dry seeds in shade and use them for planting.

2. Seeds are soaked in cow urine for 12-24 hours. Acts as a natural disinfectant and enhances seed vigor.

3. Take Fresh neem leaves: 200–500 grams (for 1 kg of seeds) and water as required to make a paste. Collect fresh neem leaves and wash them thoroughly to remove dirt. Crush or grind the leaves into a fine paste using a mortar and pestle or a grinder. Mix the paste with a small amount of water to achieve a spreadable consistency. Coat the seeds evenly with the neem paste, ensuring all seeds are covered. Allow the treated seeds to dry in shade for 2–3 hours before sowing.

4. Mix turmeric powder with seeds at a rate of 5–10 grams per kilogram of seeds. Coat the seeds evenly and allow them to dry in the shade before sowing. Prepare a paste using turmeric powder and a small amount of water. Apply the paste to the seeds and let them dry in the shade. Mix turmeric powder with crushed neem leaves or neem powder for dual-action protection against pathogens and pests. Dissolve 10 grams of turmeric powder in 1 liter of water. Soak the seeds for 2–3 hours, then dry them in the shade before planting.

5. Slightly moisten the seeds by sprinkling water, cow urine, or Beejamrut over them. Add fine wood ash to the moistened seeds. Mix thoroughly until the seeds are uniformly coated with ash. Spread the treated seeds in a single layer and air-dry them in the

shade for 2–3 hours. Once dry, sow the seeds or store them in a moisture-free environment.

6. Place the seeds in a clean, dry container. Sprinkle lime powder evenly over the seeds. Mix thoroughly until all seeds are uniformly coated. Allow the treated seeds to dry in shade before sowing.

For wet coating: Lime powder: 10–20 grams per kilogram of seeds. Water: Enough to moisten the seeds lightly. Slightly moisten the seeds using water or a natural adhesive like cow urine. Sprinkle lime powder over the moistened seeds and mix thoroughly. Dry the seeds in shade for 2–3 hours before planting.

7. Lightly coat the seeds with buttermilk to create a moist surface. Sprinkle wood ash, lime powder, or neem powder over the seeds for additional protection. Mix thoroughly and dry the seeds in shade before planting.

8. Mix 100 grams of salt per liter of water in a clean container. Stir well to dissolve the salt completely. Add the seeds to the prepared salt water solution. Stir gently to ensure all seeds are submerged. Allow the seeds to settle for 2–5 minutes: Viable Seeds: Sink to the bottom. Non-Viable Seeds: Float on the surface. Skim off the floating seeds and discard them. Collect the viable seeds from the bottom. Wash the selected seeds thoroughly with fresh water to remove excess salt. Air-dry the seeds in shade for 2–3 hours before sowing.

A. Cropping system practices

ii) Name of the practice:

A) Parallel Multiple cropping	B)Sequential Multiple cropping
1) Multilayer cropping	1) Sequential cropping
2) Mixed cropping	2) Double cropping
3) Intercropping	3) Triple cropping
4) Relay cropping	4) Quadruple cropping
5) Alley cropping	

ii. Brief description of the practice:

A) Parallel multiple cropping

1. Multilayer cropping is a modern integrated cropping system where multiple crops are grown on a single field without relying on a single crop. In this system, symbiotic crops are intercropped or mixed between the main crops, considering factors such as plant height, sunlight intensity, root area, and the symbiosis between different crops. This approach allows the ground to be fully covered, and when several crops are grown together, one crop benefits from the nutrients provided by the others. Additionally, the inclusion of various layers and trees in the field creates a soil biome that enhances carbon sequestration, improves water retention, increases nutrient availability, and boosts farmers' income year-round. Trees also contribute to microclimate regulation, reducing temperature, and promoting rainfall.

2. Mixed cropping in natural farming is the practice of growing two or more different crops simultaneously in the same field, without a fixed pattern, to enhance biodiversity and optimize land use. This system leverages complementary relationships between crops, such as varying root depths, growth habits, or nutrient requirements, to improve soil fertility, reduce pest and disease pressure, and increase overall resilience. By diversifying crop species, mixed cropping helps in weed suppression, promotes efficient nutrient cycling, and reduces the dependency on synthetic inputs, all while supporting ecological balance and sustainability in natural farming.

3. Intercropping enhances productivity by planting two or more crops together on the same plot, using row patterns like 1:1 or 1:2, where the primary crop is in the first row and subsidiary crops in subsequent rows. It is especially useful for small farmers relying on rain. The crops, though having different nutrient needs, are chosen to optimize resource use and prevent pest and disease spread. The subsidiary crop should grow faster and be harvested earlier, complementing the main crop's growth. Crops should have different root depths to avoid competition and agronomic practices for both should align. Erect crops can be paired with cover crops like pulses to reduce soil erosion, control weeds, and minimize water loss. Avoid crops with similar pest or disease and ensures planting and management is simple, efficient, and profitable for wider adoption.

4. Relay cropping is a unique cropping practice where a second crop is planted before the previous one has been harvested, allowing both crops to share a portion of the growing season. Examples of relay cropping include planting rice (or wheat) alongside Black gram, onions, lady's fingers and maize simultaneously. This approach reduces risks associated with relying solely on a single crop, as farmers can simultaneously grow multiple crops in the same field.

5. Alley cropping is an agroforestry practice where trees or shrubs and agricultural crops are grown in alternating rows. Trees are often pruned to minimize shading of crops. This method supports nutrient cycling and erosion control. Alley cropping replicates a savanna structure, with multiple canopy layers: an over story of nut trees, a mid-layer of fruiting trees and shrubs, and a groundcover of annual crops or perennial grasses. E.g. Growing of pineapple, sweet potato, black pepper, tapioca, turmeric, ginger etc. in coconut or arecanut.

B) Sequential Multiple cropping

1. Sequence cropping in this cropping system two or more crops are grown in sequence one after another on the same piece of land in a year.

2. Double cropping It is multiple cropping system in which two crops are grown in sequence on the same piece of land in a year. e.g. Black gram-Jowar, Black Gram-Wheat, Rice-Gram, Groundnut-Wheat etc.

3. Triple cropping It is the multiple cropping system in which three crops are grown in sequence on a same land in a year. It is possible when irrigation facilities are available throughout the year. e.g. Groundnut-Wheat-Okra, Rice-Wheat-G.nut, Jowar-Potato-Green gram, Soybean-Wheat-G.nut etc.

4. Quadruple cropping It is the multiple cropping system in which four crops are grown in a sequence on the same land in a year. It is possible under irrigated conditions throughout the year. e.g. Groundnut-Coriander-Wheat-Green gram, Soybean-Methi-Wheat-Green gram etc.

ii) Benefits of the practices (impacts):

1. The multilayer cropping system offers several benefits, including reduced farming costs and consistent income throughout the year. It allows for higher production per unit area, optimizing land, water, and resource use. The system also mitigates the risk of crop damage from climate change, improves soil characteristics, and enhances soil moisture retention, which boosts nutrient utilization efficiency. By maintaining environmental balance, the system reduces water evaporation, saving up to 70% of water. Additionally, the presence of more friendly insects decreases the impact of pests and diseases. As the land is fully covered with crops, weed growth is minimized, leading to increased productivity.

2. Mixed cropping the crops included in mixed cultivation system are in herently in tune with the local ecological and climatic system. The different crops are supportive of each other rather than competitive as the creepers of legumes uses stems of grain plants as a natural support and replenishing nitrogen, while the grain roots grip the soil firmly, preventing soil erosion. The diverse root system hold the soil tightly and much efficiently along with prevention of soil erosion, water loss and maintains the water holding capacity of soil particles with increasing nutrient quality of soil. In these traditional cropping system, Simultaneous cultivation of multiple crops prevents not only the losses by pests but also shows effective for weed control.

3. Intercropping offers several advantages, including increased profit, as secondary crops can provide higher yields and guarantee income even if the primary crop fails. It ensures more efficient land use compared to monocropping by planting species between rows, reducing unused soil space. Intercropping also protects cash crops by deterring pests, attracting beneficial insects, and providing shade from excessive sunlight or wind, which reduces the need for chemical pesticides and lowers costs. Additionally, the roots of plants in alley intercropping help prevent soil erosion and crusting. Leguminous plants contribute nitrogen to the soil and enhancing soil fertility. This method also allows for more efficient use of natural resources such as water and solar energy, benefiting secondary crops. Weed management is improved as beneficial plants occupy the spaces between rows, and the overall biodiversity and ecological stability are enhanced by the increased variety of agricultural species.

4. Relay cropping offers numerous benefits for natural farming, including improved soil quality, as it enhances soil fertility and structure by incorporating different crops that contribute unique nutrients. It also aids in pest and weed control by disrupting pest cycles and suppressing weed growth. By overlapping crop cycles, relay cropping ensures more efficient use of resources like water and nutrients. This method saves time and money by optimizing labor and reducing the need for additional inputs. It helps prevent soil degradation by maintaining ground cover and promoting soil health. Additionally, relay cropping can increase farm profitability by optimizing land use and boosting crop yields, addressing issues like resource inefficiency, timing conflicts, and soil degradation.

5. Alley cropping, which involves planting trees or shrubs alongside crops, offers several benefits. It improves soil structure and fertility by adding organic matter from the trees and shrubs, and helps reduce soil erosion, particularly in sloping areas, through the roots of these plants. This technique also enhances water quality by minimizing nitrogen leaching and controlling erosion. Alley cropping creates a favorable microclimate, increasing shade and reducing wind, which can boost crop performance. Additionally, it

enhancing soil fertility and controlling weeds. The practice promotes biodiversity by providing habitats for wildlife, diversifies farm income through short-term crop sales and long-term tree products, and contributes to climate change adaptation and mitigation by improving environmental resilience.

(iv) Protocols to be followed:

1. Multilayer cropping

The multilayer cropping system involves the classification of crops based on their sunlight intensity requirements in a multilayer cropping system. Group 1 Crops belonging to this group can withstand the most intense heat of the solar energy 8000 to 12000 candle feet, and during this whole time they keep the leaf openings open to make food so that more production can be taken. Fruit crops like tamarind, mango, sapota, jamun, cashew, coconut and monocots crop like sugarcane, paddy, maize, millet and fodder crops are also included. Crops belonging to this group are long-term investments with high economic returns and contribute to carbon sequestration.

Group 2 Under this group 6,000 to 8,000 candle feet of solar energy keep the leaves open all the time and produce more food through photosynthesis. Fruits like ber, guava, bitter gourd, etc., and all types of pulse crops are not exposed to severe heat but thrive in the sun with light shade. Cultivation and pruning are necessary to manage light to the lower levels and to maintain the desired shape and density of the tree. By reducing the intensity of sunlight, the lower level plants get moderate shade which is useful for their growth. Regular income can be earned by harvesting fruits in this level.

Group 3 Under this group, plants produce food with 5000 to 6000 candle feet of solar energy. This group includes medium-sized fruit trees and succulent crops, which thrive in environments with moderate light intensity, benefiting from indirect sunlight to support their growth and productivity.

Group 4 Under this group 3700 to 5000 candle feet of solar energy keep the leaves open all the time and allowing for increased food production through photosynthesis. e.g. All tuber crops include turmeric, ginger, chillies and alavi etc.

Group 5 In this group, plants in less than 3700 candle feet of light keep their stomata open and make food. This includes herb plants, cucurbitaceous crops. Thus, through this multilayer cropping system, the amount of sunlight required for photosynthesis is adequate for production. Therefore, optimizing the management practices outlined above will enhance natural farming. In this way, by combining the multilayer cropping

system, agricultural production can be enhanced more efficiently. This method helps to make agriculture more efficient by making the best use of natural resources.

2. Mixed cropping

Crop selection: Choose a variety of crops with complementary growth habits, nutrient needs, and root depths. Ensure that these crops can co-exist without competing for the same resources, thereby supporting biodiversity. Crop selection should follow the criteria below:

- If the main crop is a monocot, the mixed/allied crop should be a dicot.
- If the main crop is deep rooted, then shallow rooted mixed/allied crop should be selected.

The growing duration of a mixed/allied crop should be less than half or one-third of the main crop. That means, it should be ready in less time than the main crop. The shadow of mixed/allied crops should not fall on the leaves of main crop. Mixed/allied crops should proliferate and cover the soil thoroughly like cucumber, water melon etc.

- If the leaves of the main crop can tolerate intense sunlight, then mixed/allied crops that do not require intense sunlight should be planted.
- If the primary crop grows quickly, select a mixed/allied crop that grows slower than the main crop.

By following these protocols, mixed cropping can enhance ecological balance, support sustainable farming, and reduce reliance on synthetic inputs, as outlined in the paragraph.

3. Intercropping: crop selection should focus on choosing varieties with complementary growth habits, nutrient requirements, and root depths to ensure that the crops can coexist without competing for resources, thus supporting biodiversity. The selection should follow these criteria:
(i) If the main crop is a monocot, the mixed or allied crop should be a dicot.
(ii) If the main crop is deep-rooted, a shallow-rooted mixed/allied crop should be chosen.
(iii) The growing duration of the mixed/allied crop should be less than half or one-third of the main crop's growing period, ensuring it matures sooner.
(iv) The shadow of the mixed/allied crops should not fall on the main crop’s leaves.
(v) Mixed/allied crops should spread and cover the soil effectively, like cucumbers or watermelons.
(vi) If the main crop can tolerate intense sunlight, plant mixed/allied crops that do not require strong sunlight.

(vii) If the main crop grows quickly, select a slower-growing mixed/allied crop. By adhering to these guidelines, intercropping can enhance ecological balance, promote sustainable farming practices, and reduce reliance on synthetic inputs.

4. Relay cropping in relay cropping system should ensure optimal crop growth, minimal competition, and improved soil health. Start by selecting compatible crops with different growth durations and ecological needs, so one crop can establish while the other is still growing. The main crop is planted first, followed by the relay crop, seeded before the main crop is fully harvested. The relay crop should complement the main crop's growth habits, such as pairing deep-rooted crops with shallow-rooted ones, to optimize nutrient and water use. Timing is crucial to avoid shading and competition for sunlight, with proper spacing for airflow and root expansion. Select relay crops that enrich the soil, like nitrogen-fixers, and diversify crop species to maintain biodiversity and reduce pest pressure. Monitor soil fertility and implement practices like mulching, composting, and crop rotation to enhance soil health. Regular monitoring of crop growth is essential to adjust the system for successful and sustainable relay cropping.

5. Alley cropping In alley cropping system should aim to optimize plant growth, maintain soil health, and minimize resource competition. This system involves planting rows of trees or shrubs, often nitrogen-fixing, alongside crops, creating alleys for crop growth. The trees provide shade, windbreaks, and organic matter, while reducing soil erosion and improving the microclimate. Choose tree species that complement the crops and are suited to the local environment, ensuring minimal competition for sunlight, water, and nutrients. Proper spacing of trees is crucial to allow crops to thrive. Pruning or thinning must be timed to prevent excessive shading and ensure adequate sunlight for crops. Leguminous crop should be used to enhance soil fertility through nitrogen fixation. Regular monitoring of plant health, soil fertility, and moisture levels is essential to ensure long-term productivity and ecological balance.

Water management in natural farming

I. Name of practices

1. Drip Irrigation
2. Micro-Sprinklers
3. Moisture Sensors

II. Brief description of the practices:

1. Drip irrigation is a water-efficient farming technique that delivers water directly to plant roots through a system of tubes, pipes and emitters. It minimizes water wastage by

reducing evaporation and runoff, promoting healthier plants and conserving water. Drip irrigation in natural farming helps create a VAPSA condition by efficiently delivering water directly to plant roots, promoting healthy soil structure and moisture retention. It minimizes water wastage, supports microbial life and reduces stress on plants, fostering a balanced and thriving ecosystem in natural farming.

2. A micro-sprinkler is a small irrigation device that distributes water in fine droplets or a gentle spray over a targeted area, similar to natural rainfall. It is designed to cover a small to medium-sized area and is typically used in gardens, orchards or greenhouses. Micro- sprinklers provide efficient water distribution, reduce evaporation and ensure uniform irrigation, promoting healthy plant growth while conserving water. Micro-sprinklers in natural farming help create a VAPSA condition by evenly distributing water over the soil surface, fostering healthy plant growth and soil moisture retention. This gentle irrigation method promotes soil life, reduces water wastage and supports a balanced, thriving ecosystem, essential for sustainable farming.

3. Moisture sensors in natural farming help create a VAPSA condition by providing real-time data on soil moisture levels. This allows for precise irrigation, preventing overwatering or underwatering and maintaining optimal moisture for plant health. The sensors promote healthy soil structure, support microbial life and conserve water, enhancing overall farm sustainability.

III. Benefits of the practices

1. VAPSA Condition: Water management is indeed crucial in natural farming for creating a favourable microclimate and ensuring the health of crops, soil and the surrounding ecosystem. VAPSA (Vapour-Aided Plant Soil Air) conditions is a sophisticated concept that works with the principles of capillary action to ensure plants receive adequate moisture without over-relying on irrigation systems.

2. Capillary action refers to the ability of water to move through the soil or any porous medium due to the forces of adhesion and cohesion. Water naturally rises through the small pores in the soil, moving from wetter areas to drier areas. This is especially important for plants, as capillary action ensures that the root zone remains moist and plants get water even when there are no immediate sources of irrigation.

Principles of VAPSA Condition in Water Management
In natural farming, VAPSA (Vapor-Aided Plant Soil Air) water management leverages capillary action to ensure plants get sufficient moisture while minimizing water wastage.

Here's how it works:

- Vapor (Humidity): High humidity reduces evaporation, keeping moisture in the soil, which supports capillary rise and water retention.
- Air (Soil Aeration): Proper aeration prevents soil compaction, allowing water to move through pores and reach plant roots via capillary action.
- Plant (Root System): Healthy, deep-rooted plants access water from deeper soil layers, optimizing capillary water uptake.
- Soil (Water-Holding Capacity): Well-structured, organic-rich soil retains moisture, aiding capillary rise and reducing water loss.
- Atmosphere (Climate Control): Temperature and humidity management (through shade, windbreaks or mulching) prevent excessive evaporation and stabilize moisture levels.

Water Management Techniques to Support VAPSA Conditions

To enhance capillary action and ensure plants get enough water under VAPSA conditions, the following natural farming techniques can be applied: Mulching, using organic materials like straw, leaves and grass clippings, helps retain soil moisture by reducing evaporation and improving the soil's ability to hold water, which supports capillary movement. Cover cropping, with plants such as legumes, clovers and grasses, prevents soil erosion, enhances organic matter content and maintains soil moisture, creating favourable conditions for capillary action. Contour farming techniques capture rainwater and slow runoff, allowing it to infiltrate the soil for capillary action. Swales also promote localized microclimates that aid in moisture retention. Rainwater harvesting captures water for irrigation during dry periods, ensuring consistent moisture levels for capillary rise. Encouraging deep-rooted plants enables them to access moisture from deeper soil layers, helping them withstand drought and utilize water through capillary action. Agroforestry, through planting trees and shrubs, stabilizes the microclimate by providing shade, reducing wind and increasing humidity, which improves water retention in the soil. Finally, soil aeration practices, such as minimal tillage and adding organic matter, maintain soil porosity, allowing water to move efficiently through the soil via capillary action.

IV. Protocols to be followed

Irrigation practices and water conservation strategies play a crucial role in supporting soil health by maintaining moisture levels that promote a healthy, active and balanced soil food web. For instance, effective water management can help farmers prevent soil degradation issues like waterlogging, salinization and surface crusting, which can occur due to the impact of overhead irrigation on bare soil. In natural farming, micro irrigation

protocols focus on promoting sustainability and soil health. First, install micro-irrigation systems, like drip or micro-sprinklers, to ensure efficient water delivery directly to plant roots. Use organic mulches to minimize evaporation. Maintain proper soil structure and avoid over-irrigating, which can disrupt soil microbes. Regularly monitor moisture levels with sensors to adjust water usage based on plant needs. Ensure the water quality is free from chemicals and pollutants. Lastly, ensure the system is regularly maintained to prevent clogging and ensure long-term efficiency.

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Annexure- VII

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1. **Name of Crop: Apple**

2. **Natural Farming Practices:**

a. **Soil Health Management Practices:**

   a. **Name of the practice**: Application of ghan jeevamrut , soil and foliar application of jeevamrut, intercropping, mulching.
   b. **Brief description of the practice**:
      i. **ghan jeevamrut application at the time of field/ basin preparation:**
         1. In rootstock plants: 200gm/plant
         2. In seedling plant: 400gm/plant
         3. Application at time of intercropping @10 q/ha
      ii. **jeevamrut drenching at an interval of 21 days:**
         1. In rootstock plants: 3L/plant
         2. In seedling plant: 5L/plant

   Jeevamrut spraying at an interval of 15 days: 10L in 100L water

      a. Application of ghan jeevamrut and jeevamrut in soil and foliar application of jeevamrut @ 10 % at 15 days interval provide congenial conditions/ culture for multiplication of beneficial microbes which make nutrients available to the plants. Using intercrops with at least one leguminous crop fixes atmospheric nitrogen. Use of mulch (dry/ live) conserve soil moisture and make congenial conditions for microbial and earthworm activities.

i. **Benefits of practices (Impacts):** All these practices improve nutrient availability, improve soil organic carbon and humus as well as soil microbial activities and soil enzymatic activities.

ii. **Protocols to be followed:** Application of ghan jeevamrut @ 10 q/ha, soil and foliar application of jeevamrut @ 10 % at 15 days interval, using intercrop with atleast one leguminous crop, use of mulch (dry/ Live).

b. Nutrient Management Practices:

i. **Name of the practice**: Application of ghan jeevamrut , soil and foliar application of jeevamrut, intercropping and mulching.

ii. **Brief description of the practice**: Application of ghan jeevamrut @ 10 q/ha and soil and foliar application of jeevamrut @ 10 % at 15 days interval provide congenial conditions/ culture for multiplication of beneficial microbes which make nutrient available to the plants. Using intercrop with atleast one leguminous crop fix atmospheric nitrogen. Use of mulch (dry/ live) conserve moisture and make congenial conditions for microbial and earthworm activities

iii. **Benefits of practices (Impacts):** All these practices improve nutrient availability, improve soil organic carbon and humus as well as soil microbial activities and soil enzymatic activities.

iv. **Protocols to be followed:** Application of ghan jeevamrut @ 10 q/ha, soil and foliar application of jeevamrut @ 10 % at 15 days interval, using intercrop with atleast one leguminous crop, use of mulch (dry/ live).

c. **Pest and Disease Management Practices:**

i. **Name of the practice**: Application of beejamrut, agnister, brahmaster, Neemaster/ Drakeaster, Dashparni ark, 3-5 days butter milk, saunthaster.

ii. **Brief description of the practice**: Seed treatment of different intercrops with freshly prepared beejamrut @ 10-20 %.

Foliar application of agnister, brahmaster, Neemaster, Drakeaster, Dashparni ark @ 3 %, 3-5 days butter milk, saunthaster @ 3-5% at different plant stages for the management of diseases and insect pests of apple:

iii. **Benefits of practices (Impacts):** All these practices act as pest repellent and pathogen protectants. Other natural farming practices like intercropping act barrier for spread of pests and pathogens. Improvement in population of beneficial microbes result bicontrol of the pathogens. Mulching and bio-inoculants like jeevamrut and ghan jeevamrut create a

protective barrier and suppress soil-borne pathogens, promoting soil health and plant growth.

iv. **Protocols to be followed:** Seed treatment with freshly prepared beejamrut @ 10-20 %. Foliar application of agnister, brahmaster, Neemaster, Drakeaster, Dashparni ark @ 3%, butter milk, saunthaster @ 3-5% at different plant stage as per detail given below for the management of diseases and insect pests of apple.

Sprayed natural preparations at 15-day intervals/ as and when required for management of diseases and insect pests

- ✔ **Sonthastra, khatti lassi, ramban rognashi, and jeevaamrit for fungal foliar diseases**
- ✔ **Darekastr, bhramastr, and agniastr for insect pest management**
- ✔ **Dashparni ark for woolly apple woolly aphid control**

Foliar application

- jeevamrut :10L in 100L water
- Khatti lassi (Butter Milk) :5L in 100L water
- Ramban: 7L jeevamrut+ 3L lassi in 100L water
- Sonthastr: No dilution
- Darekastr: No dilution
- Agniastr: 5L in 100L water
- Brahmastr: 5L in 100L water
- Dashparni ark: 5L in 100L water

Spray schedule for the control of insect of apple

Tree Stage		**Pests Targeted**	**Keetnaasi Astra** (NF) sprayed for management of pests under NF	**Keetnaasi Astr**
Half-inch/ Green tip		Sanjose scale/mites		**Neem oil (5lts)**
Pink bud		Thrips		**-**
Petal fall		Sanjose scale/ Mite	Sanjose scale/ woolly apple aphid	**Agniastr/ Bhramastr/ Dashparni ark**
Fruit Development (Walnut size)		Mite	Woolly apple aphid	**Darekastr/ Bhramastr/ Agniastr/ Dashparni ark**

Fruit development (20-25 days after 3rd spray)		Mite	Woolly apple aphid	**Bhramastr /Agniastr**
Fruit development (20 days after 4th spray)		Mite	Defoliating beetles Woolly apple aphid	**Darekastr/ Dashparni ark**
Pre harvest		Sanjose scale/ Aphid	-	**-**
Post harvest		Woolly apple aphid	Woolly apple aphid	**Agniastr**

Spray schedule for the management of diseases of apple under NF

	Tree Stage		**Diseases Targeted**	**Rognashi Dawa for management of diseases**
	Green tip		Powdery mildew	**Khatti lassi (Butter milk)**
	Pink bud		Powdery mildew	**-**
	Petal fall/ Pea Stage		Powdery mildew, Alternaria leaf spot	**Sonthastr / Khatti lassi/ Ramban rognashi dawa**
	Fruit Development (Walnut size)		Alternaria leaf spot/ pre mature leaf fall	**Khatti lassi / Ramban rognashi dawa/ Sonthastr**
	Fruit development (20-25 days after 4th spray)		Pre mature leaf fall/ Alternaria leaf spot	**Ramban rognashi dawa / Kandiastr**
	Fruit development (After 5th spray)		Alternaria leaf spot/ premature leaf fall	**Khatti lassi / Ramban rognashi dawa**
	Pre harvest		Sooty blotch/ fly speck/ Alternaria leaf spot/ Premature leaf fall	**Kandiastr /Sonthastr**
	Post harvest		Cankers	**jeevamrut**

d. Weed Management Practices:

i. **Name of Practice:** Mulching/ Achhadan, live mulch, intercropping, ghan jeevamrut .

ii. **Brief description of the practice**: Mulching/ Achhadan with dry grass / crop residues in the tree basin, Sowing of different intercrops in between the plants as well as in between the rows, application of ghan jeevamrut @ 10q/ha.

iii. **Benefits of practices (Impacts):** Soil surface remain covered during crop season and not allowed weed to germinate and etiolate. ghan jeevamrut remain free from weed seed.

iv. **Protocols to be followed:** Mulching/ Achhadan with dry grass / crop residues in the tree basin 2-3 times in a year, Sowing of different intercrops in between the plants as well as in between the rows, ghan jeevamrut @ 10q/ha.

e. Water Management Practices:

i. **Name of Practice:** Mulching/ Achhadan, live mulch, intercropping, Waaphasa

ii. **Brief description of the practice**: Mulching/ Achhadan with dry grass / crop residues just after crop emergence, Sowing of live mulch before transplanting, intercropping, Creation of waaphasa channels (1.5' × 1.5') outside the basin area.

iii. **Benefits of practices (Impacts**): Soil surface remain covered during crop season and reduce evaporation and conserve soil moisture. Waaphasa channels creates congenial conditions / maintaining moisture at field capacity.

iv. **Protocols to be followed:** Mulching/ Achhadan with dry grass / crop residues in the basin and Waaphasa channels, Sowing of live mulch in between the plants and plant rows, intercropping, Creation of waaphasa channels (1.5' × 1.5') outside the basin area of plants.

f. Any other practices being followed:

It is important to note that since Natural Farming is holistic farming system hence, use of all the components such as beejamrut, ghan jeevamrut , jeevamrut, achhadan, waaphasa and intercropping along with concoctions for plant protections provide maximum benefits when applied in toto in a field.

The following are the recommendations of package of practices for vegetable crops under Natural Farming:

1. Tomato+ Frenchbean + Brinjal

2. Cucumber + Frenchbean + Okra
3. Pea + Spinach + Coriander
4. Cabbage + Fenugreek + Coriander

1. **Natural Farming Practices:**

a. **Soil Health Management Practices:**

i. **Name of the practice**: Application of ghan jeevamrut , soil and foliar application of jeevamrut, intercropping, mulching.

ii. **Brief description of the practice**:
Application of ghan jeevamrut @ 10 q/ha and soil and foliar application of jeevamrut @ 10 % at 15 days interval provide congenial conditions/ culture for multiplication of beneficial microbes which make nutrient available to the plants. Using intercrop with at least one leguminous crop fix atmospheric nitrogen. Use of mulch (dry/ live) conserve soil moisture and make congenial conditions for microbial and earthworm activities.

iii. **Benefits of practices (Impacts):** All these practices improve nutrient availability, improve soil organic carbon and humus as well as soil microbial activities and soil enzymatic activities.

iv. **Protocols to be followed:** Application of ghan jeevamrut @ 10 q/ha, soil and foliar application of jeevamrut @ 10 % at 15 days interval, using intercrop with at least one leguminous crop, use of mulch (dry/ Live).

b. **Nutrient Management Practices:**

i. **Name of the practice**: Application of ghan jeevamrut , soil and foliar application of jeevamrut, intercropping and mulching.

ii. **Brief description of the practice**: Application of ghan jeevamrut @ 10 q/ha and soil and foliar application of jeevamrut @ 10 % at 15 days interval provide congenial conditions/ culture for multiplication of beneficial microbes which make nutrient available to the plants. Using intercrop with at least one leguminous crop fix atmospheric nitrogen. Use of mulch (dry/ live) conserve moisture and make congenial conditions for microbial and earthworm activities

iii. **Benefits of practices (Impacts):** All these practices improve nutrient availability, improve soil organic carbon and humus as well as soil microbial activities and soil enzymatic activities.

iv. **Protocols to be followed:** Application of ghan jeevamrut @ 10 q/ha, soil and foliar application of jeevamrut @ 10 % at 15 days interval, using intercrop with atleast one leguminous crop, use of mulch (dry/ live).

c. **Pest and Disease Management Practices:**

i. **Name of the practice**: Application of beejamrut, agniaster, brahmaster, Neemaster/ Drakeaster, Dashparni ark, sour butter milk, saunthaster.

ii. **Brief description of the practice**: Seed treatment with freshly prepared beejamrut @ 10-20 %. Foliar application of agnister, brahmaster, Neemaster, Drakeaster, Dashparni ark @ 3 %, sour butter milk, saunthaster @ 3-5% alternatively at weekly intervals, just after 15 days of transplanting. In case of cucumber start spray of different asters at cotyledon stage.

iii. **Benefits of practices (Impacts):** All these practices act as pest repellent and pathogen protectants. Other natural farming practices like intercropping act barrier for spread of pests and pathogens. Improvement in population of beneficial microbes result biocontrol of the pathogens. Mulching also creates barrier for soil borne pathogens.

iv. **Protocols to be followed:** Seed treatment with freshly prepared beejamrut @ 10-20 %. Foliar application of Agniaster, Brahmaster, Neemaster, Drakeaster, Dashparni ark @ 3 %, sour butter milk, saunthaster @ 3-5% alternatively at weekly intervals, just after 15 days of transplanting. In cucumber at cotyledon stage. Incorporation of antagonistic crops should be done while selecting the intercrop.

d. **Weed Management Practices:**

i. **Name of Practice:** Mulching/ Achhadan, live mulch, intercropping, ghan jeevamrut .

ii. **Brief description of the practice**: Mulching/ Achhadan with dry grass / crop residues just after crop emergence, Sowing of live mulch before transplanting, intercropping, application of ghan jeevamrut @ 10q/ha.

iii. **Benefits of practices (Impacts):** Soil surface remain covered during crop season and not allowed weed to germinate and etiolate. ghan jeevamrut remain free from weed seed.

iv. **Protocols to be followed:** Mulching/ Achhadan with dry grass / crop residues just after crop emergence, Sowing of live mulch before transplanting, intercropping, ghan jeevamrut @ 10q/ha.

e. **Seed Selection, treatment and sowing practice:**

i. **Name of Practice:** Use of Open Pollinated varieties in natural farming.

ii. **Brief description of the practice**: Seeds of OP varieties of the vegetables released and recommended by the University for the State are used for growing the vegetables under natural farming system.

iii. **Benefits of practices (Impacts**): All the varieties of vegetables are well adapted to this region and are less prone to various diseases and insect pests.

iv. **Protocols to be followed:** The seeds of all the vegetables are treated with freshly prepared beejamrut before sowing, dried in shade for 1-2 hours and sown in nursery or directly sown in the field at proper spacing as per the crops and cropping system.

f. **Cropping Systems:**

i. **Name of Practice:** Multiple/ intensive cropping system.

ii. **Brief description of the practice**: Two or more crops are grown on the same piece of land in succession within one calendar year. During the Kharif season the main crops are tomato, cucumber and capsicum and intercrops are French bean, brinjal and okra while in Rabi season the main crops are pea, cabbage and intercrops are fenugreek, coriander spinach or radish/turnip.

iii. **Benefits of practices (Impacts**): In multiple cropping systems we get maximum production of crops per unit area per unit time. There is also multiple use of resource. We can grow more number of crops within a year & more number of crops on the same piece of land at any given period. By growing the diverse crops there are less attack of diseases and insect pests.

iv. **Protocols to be followed:** Main crops are sown/ transplanted in the rows and intercrops are sown in between the main crop rows by following the proper spacing as per the crops.
All the crops are raised by following the natural farming practices.

g. **Water Management Practices:**

i. **Name of Practice:** Mulching/ Achhadan , live mulch, intercropping, Waaphasa

ii. **Brief description of the practice**: Mulching/ Achhadan with dry grass / crop residues just after crop emergence, Sowing of live mulch before transplanting, intercropping, Creation of waaphasa channels (1.5’ × 1.5’) at 1.2 m distance.

iii. **Benefits of practices (Impacts**): Soil surface remain covered during crop season and reduce evaporation and conserve soil moisture. Waaphasa channels creates congenial conditions / maintaining moisture at field capacity.

iv. **Protocols to be followed:** Mulching/ Achhadan with dry grass / crop residues just after crop emergence, Sowing of live mulch before

transplanting, intercropping, Creation of waaphasa channels (1.5’ × 1.5’) at 1.2 m distance.

h. **Any other practices being followed:**
It is important to note that since Natural Farming is holistic farming system hence, use of all the components such as beejamrut, ghan jeevamrut , jeevamrut, achhadan, waaphasa and intercropping along with concoctions for plant protections provide maximum benefits when applied in toto in a field.

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Annexure- VIII

Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya (CSKHPKV), Palampur, Himachal Pradesh

1. **Natural Farming practices:** The natural farming practices and its concept are based upon the four principles/ components i.e. beejamrut, jeevamrut, Achadana (Mulching) and Whapsa (Moisture). These four components need to be applied in totality, and skipping any leads to considerable reduction in the crop yield.

a. Soil health management practices		
Name of the practice	:	**Application of jeevamrut, Achadana and Whapsa**
Brief description of the practice	:	**jeevamrut** is the efficient application of consortium of beneficial organisms and nutrients in growing crops to improve productivity. It is top dressed @ 10% at 14-days interval, till the grain filling stage. **Achadana (Mulching)** is one of the important components of natural farming. In this practice, the surface around the crop is covered with natural mulch mainly straw, dry grass, crop residues etc. It is applied @ 10 t/ha on dry weight basis. **Whapsa (Moisture)** is a practice of growing crops on raised bed not more than 1.5-2.0 m width and forming a channel of 10-15 cm deep, facilitates the availability of air and moisture to the roots as well as microorganisms living in the soil.
Benefits of the practice (Impacts)	:	**Application of jeevamrut** increases soil fertility, activity of beneficial micro-organisms in the soil and crop yields. These microorganisms have antagonistic effects on pathogenic fungus, bacteria in the roots as well as foliage and also provide nutrition to the crop. **Achadana (Mulching)** is helpful in suppressing the weeds, better management of upper soil surface, addition of organic matter, moderation soil temperature & moisture and protect the crop against soil borne diseases. It creates the micro-climate, darkness and warmth in the soil under which micro-organisms can develop and proliferate. **Whapsa (Moisture)** favours better roots growth and ultimately efficient utilization of resources resulting in better crop growth & yield.

Protocols to be followed	:	**jeevamrut** should be used within 7-8 days of its preparation and must be prepared from cow dung and cow urine. It should be sprayed at 14 days interval.
b. Nutrient management practices		
Name of the practice	:	**Application of ghan jeevamrut and jeevamrut**
Brief description of the practice	:	It is necessary to balance the amount of nutrients in the soil depending upon the crop growth stage. It is applied @ 500 kg/ha at sowing of crops. For meeting out the nutrient requirement of more exhaustive crops, ghan jeevamrut must be applied @ 1000 kg/ha. Whereas, jeevamrut should be sprayed at fortnightly interval.
Benefits of the practice (Impacts)	:	ghan jeevamrut makes the soil fertile and increases the crop yield.
Protocols to be followed	:	It should not be older than six months and must be prepared from cow dung and cow urine.

c. Pest and Disease management practices		
Name of the practice	:	**Application of Botanicals and Bio formulations**
Brief description of the practice	:	To bar the menace of destructive insect-pests and diseases in different crops under natural farming system, the prophylactic sprays with the extracts of potential insecticidal plants and cow urine & dung based bio formulations at 10 days interval like Fermented butter milk, Ram baan, Neemastra, Darekastra, Dashparni etc. is mandatory
Benefits of the practice (Impacts)	:	These extracts and bio formulations are locally available, cost effective, residue free and eco-friendly
Protocols to be followed	:	These must be sprayed @ 200 l/acre as 10% prophylactic and in rotation right from the 15 days old crop till maturity
d. Weed management practices		
Name of the practice	:	**Application of Achadana (Mulching) and Intercropping**
Brief description of the practice	:	The surface around the crop is covered with natural mulch mainly straw, dry grass, crop residues etc. It is applied @ 10 t/ha on dry weight basis.

		On the other hand, the inclusion of legume crops as intercrop acts as complementary with SPNF inputs, in comparison to sole crop.
Benefits of the practice (Impacts)	:	It is helpful in suppressing the weeds, better management of upper soil surface, addition of organic matter, moderation soil temperature & moisture and protect the crop against soil borne diseases. It creates the micro-climate, darkness and warmth in the soil under which micro-organisms can develop and proliferate.
Protocols to be followed	:	Perform manual weeding at early stages of crop i.e. 15-30 days after sowing. Whereas, incorporation of legumes as intercrop suppress the weeds, improves the soil health and yield of the main crop.
e. Seed selection, treatment and sowing practices		
Name of the practice	:	**Application of beejamrut**
Brief description of the practice	:	beejamrut is an ancient amazing formulation & very common practice under modern natural farming. It is used for seed treatment, seedling and other planting material. Treat the dry seeds thoroughly with freshly prepared beejamrut (24 hrs required for preparation) not older than 2-3 days applied @ 100-200 ml/kg seed. Treated seeds are air dried in the shade for 10 to 15 minutes.
Benefits of the practice (Impacts)	:	It protects the seed from seed/soil borne pathogens and soil borne insect pests, provides the strength to the root system and improves the seed germination viability. It cost very less and require little time for preparation.
Protocols to be followed	:	beejamrut should be prepared fresh & need based and can be mixed with biofertilizers before use. It must be used with in 2 days of its preparation.
f. Cropping systems		
Name of the practice	:	**Intercropping and Crop rotation**
Brief description of the practice	:	The inclusion of legume crops as intercrop acts as complementary with SPNF inputs, in comparison to sole crop. Crop rotation is the practice of growing different crops sequentially on the same plot to improve soil health, optimize nutrients in the soil, and combat pest and weed pressure.

Benefits of the practice (Impacts)	:	Intercropping improves the crop equivalent yield (CEY), fertility status and microbial properties of the soil. Whereas, crop rotation improves water use efficiency by increasing the amount of organic matter in the soil, which improve soil structure and water-holding capacity. It also helps in preserving moisture in deep soil layers, which plants can use during droughts.
Protocols to be followed	:	Suitable legumes should be planted following the additive series or replacement series.
g. Water management practices		
Name of the practice	:	**Whapsa (Moisture)**
Brief description of the practice	:	Growing crops on raised bed not more than 1.5-2.0 m width and forming a channel of 10-15 cm deep, facilitates the availability of air and moisture to the roots as well as microorganisms living in the soil. Besides, crop rotation also improves the water use efficiency by increasing the amount of organic matter in the soil, which improve soil structure and water-holding capacity.
Benefits of the practice (Impacts)	:	This condition favours better roots' growth and ultimately efficient utilization of resources resulting in better crop growth and yield.
Protocols to be followed	:	Care must be taken to drain out the excess water through constructed drains around raised bed in kharif season as plenty of rainfall is there.
h. Any other practices being followed Instead of single crop, suitable cropping system should be followed to increase the production per unit area and to improve the soil health.		

Annexure- IX

University of Agricultural Sciences, GKVK, Bangalore

1.Name of the State : Karnataka

2. Natural Farming Practices :

a. Soil health management practices

i. Name of the Practice: Adoption of natural farming practices like zero tillage, mulching with crop residues, green manuring, green leaf manuring, intercropping and multilayer cropping (Five layer model)

ii. Brief Description of the Practice: Zero-tillage is practiced which avoids compaction of soil. In between the two rows of crops mulching is adopted with use of straw, crop residues or weeds. Mulching is practiced using 4 (four) tonnes of straw / crop residues / weeds per hectare. In-situ green manuring with sunhemp, sesbania, dhaiancha, velvet bean, cowpea can be practiced using 10 kg seeds per acre. Green leaf manuring with use of leaves of Glyricidia, Simarouba, neem, pongamia etc., can be practiced. Growing of short duration pulse / legume crops like green gram, black gram, cowpea, field bean, French bean, peas as intercrops in cereals, oilseeds, vegetable and plantation crops like mango, pomegranate, guava, sapota, coconut, arecanut is practiced. Five layer model can be established with timber / fruit / field crops like Teak, Mahagani, Bamboo, Coconut, arecanut, Drum stick, banana, redgram, castor, field bean, cowpea.

This practice involves the use of natural farming systems, integrating traditional farming methods with scientific insights to maintain and enhance soil health. These approaches aim to enhance the organic carbon content, microbial population, and enzymatic activity in the soil while avoiding chemical inputs. The practice also incorporates sustainable techniques like intercropping, crop residue mulching, and minimizing deep ploughing to conserve soil structure and fertility.

Fig.1. In-situ green manuring with sunhemp, dhaincha in Mango orchards

Fig.2. In-situ green manuring with Velvet bean in coconut gardens

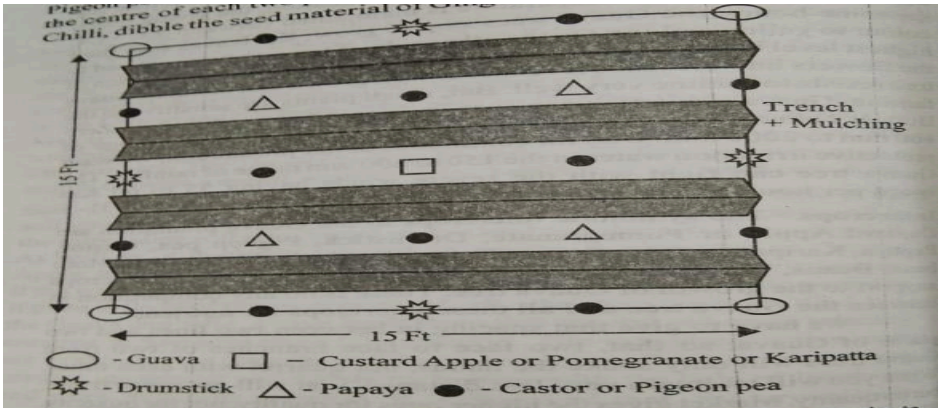

Fig.3. Five layer model in natural farming

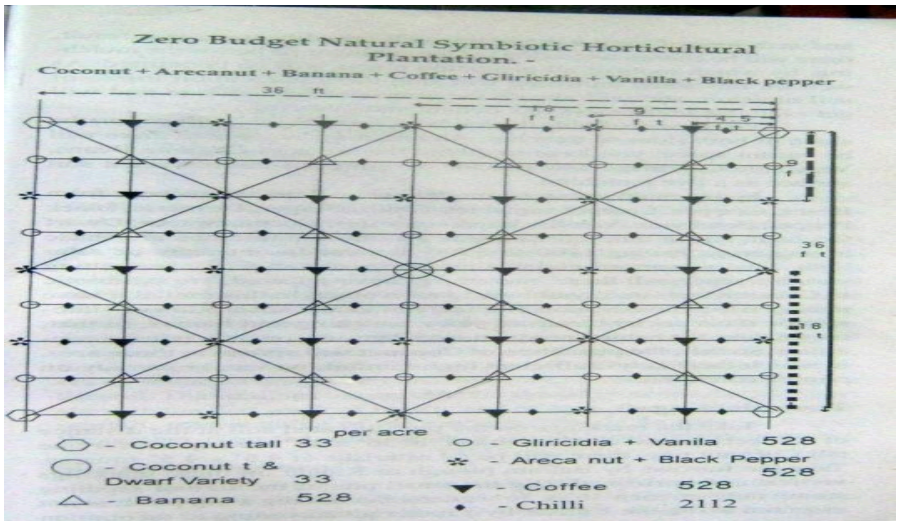

Fig.4. Five layer model in natural farming

iii. Benefits of the Practice (Impacts):

- Enhanced soil organic carbon content
- Improved nutrient availability
- Boosts soil microbial and enzymatic activity:
- Sustainability
- The practice minimizes environmental harm by avoidance of synthetic fertilizers and pesticides.

iv. Protocols to be followed:

1. **Soil testing**: Baseline soil testing need to be conducted to identify organic carbon levels, pH and nutrient deficiencies.
2. **Crop management**: Intercropping with legumes and other cover crops to enhance nitrogen fixation and reduce erosion.

3. **Residue management**: crop residue mulching to conserve moisture and increase soil organic matter.
4. **Monitoring and Evaluation**: Regularly monitoring of soil health parameters and microbial activity to assess the effectiveness of the practices.

This holistic approach ensures that soil health is maintained and enhanced, contributing to long-term agricultural sustainability and resilience against climate change

b. Nutrient management practices

i. Name of the practice : Jeevamrutha, Ghanajeevamrutha and intercropping practices

ii. Brief description of the practice : Jeevamrutha is a fermented microbial culture developed to enhance soil health by increasing the population of beneficial microorganisms. Regular application of Jeevamrutha promotes nutrient mineralization, ensuring a steady supply of nutrients to crops. Similarly, Ghanajeevamrutha not only enriches the soil with essential nutrients but also fosters the growth of soil microflora, improving overall soil fertility. Intercropping with pulses / legumes results in biological nitrogen fixation. Enormous amount of leaf litter or crop residues are added to the soils at the time of harvest of the intercrops which adds organic matter to the soil thereby improves organic carbon content in the soil.

iii. Benefits of the practices (Impacts) :

- The application of Jeevamrutha enhances soil microflora and improves nutrient availability to crops.
- Ghanajeevamrutha enriches the soil with nutrients and boosts soil health by enhancing both soil microflora and nutrient status.
- It aids in the decomposition of straw mulch used in natural farming, converting it into valuable nutrients.
- Jeevamrutha improves the mobilization and mineralization of nutrients in the soil.
- It promotes soil health by fostering the growth of both soil microflora and macroflora.
- Intercropping with pulses / legumes adds organic matter to the soil and improves the organic carbon content in the soil.

iv. Protocols to be followed :

Jeevamrutha: Add 500 liters of water in a barrel, add 25 kg fresh desi/local cow dung and 25 liters desi/local cow urine. Add 5 kg chemical free jaggery, 5 kg pulse flour and

a two – three hand full of soil from the farm.Mix the ingredients well in shade with gunny bag cover, stir in morning, afternoon and evening using wooden pole in clock-wise direction for 7 days and apply Jeevamrutha to crops in between 5th to 11the day of preparation. Dosage of Jeevamrutha prescribed is 500 litres of Jeevamrutha for one hectare of field crops once in every 15 days until harvest. For plantation crops like coconut / arecanut / mango / papaya / banana 500 litres of Jeevamrutha per hectare once in 30 days continuously.

Fig.5. Application of Jeevamrutha to crops

Ghanajeevamrutha: Mix 1000 kg of desi / local cow dung with 20 - 25 liters of desi / local cow urine, 5 kg of chemical-free jaggery, 5 kg of pulse flour, and a tow to three handful of soil from the farm. After thoroughly mixing, cover the mixture with a gunny bag and leave it overnight. The next day, shape the mixture into dung cakes or small balls and allow them to dry in the sun. Before application, grind the dried cakes into a powder and apply 1000 kg Ghanajeevamruth per hectare to the field 15 -20 days prior to sowing of field crops. For perennial plants, apply 1-2 kg per plant once in every six months. Once Ganajeevambrutha is prepared, it can be stored for up to six months.

Intercropping : The practice of growing two or more crops at same time with definite or indefinite row proportion is called as intercropping. For intercropping short duration pulses / legumes like green gram, black gram, cowpea, field bean, horsegram, groundnut, soybean, French beans etc are sown inbetween two rows of main crops so that space inbetween the rows of main crop is very efficiently utilized.

Fig.6. Muching with pulse / legume crops for better nutrient fixation

C. Pest and disease management practices

i. Name of the practice: Pest and disease management by using agni astra, neemastra, shunti astra, brahmastra and sour butter milk

ii. Brief description of the practice :

- **Seed treatment:** Seed / seedling / set treatment with beejamrutha at 1 lit/ 10 kg of seeds.
- **Spraying:** shunti astra, neemastra, agniastra and brahmastra as prophylactic measures in anticipation of pest and disease incidence.
- **Cultural practices :** Timely sowing, inter cropping, crop rotation, mulching, use of pest and disease free planting materials, use of pest and disease resistant varieties.
- **Biological practices :** Use of light traps, yellow sticky traps, boarder crops, bird perches, owls, natural predators / enemies

iii. Benefits of the practices (Impacts) :

Helps in managing the pests and diseases, ecological approach, natural predators are encouraged, biological life chain is restored, access to chemical free food.

iv. Protocols to be followed :

- **Crop rotation:** It involves growing different crops in the same area over multiple growing seasons. It's an effective way to control pests with a limited host range, long life cycle, and limited ability to move between fields.

- **Mixed cropping:** Multiple cropping, also known as mixed cropping, is a method of growing different crops at the same time to help control pests and diseases
- **Use of disease free seed materials:** Using disease-free seed or plant material can help eliminate some pathogens

Use of pest and disease resistant varieties to avoid the incidence

Regular monitoring for pest and disease incidence.

Preparation and use of astras: On farm preparation and use of need based astras viz., shunti astra, neemastra, agniastra, brahmastra and sour buttermilk.

Shunti astra: Take 2 litres of water, add 200 grams of ginger powder and mix it and cover with a lid. Now boil it till it reduces to half of the solution. Keep this solution for cooling. Take 2 litre desi cow milk in another container and boil it slowly on low flame. After boiling milk, allow it to cool down, remove the cream from the milk. Now take 200 litres of water, add a solution of ginger powder and milk without cream. Mix it properly and cover this solution with gunny bags for two hours. During this process ion exchange will occur, filter it with muslin cloth and spray this solution within 48 hours.

Neemastra (broad spectrum botanical pesticide) Take neem leaves - 5 kg, desi cow urine - 5 litres, desi cow dung - 5 kg, water - 100 litres. Take five kg of green leaves of neem or take five kg of dried fruits of neem and keep the leaves or fruits crushed. Add this crushed neem or fruit powder in 100 liters of water. Put 5 liters of cow urine in it and mix with five kg of cow dung. Stir it with wood and keep it covered for 48 hours. Dissolve thrice a day and after 48 hours filter the solution with a cloth. Now spray on the crops as prophylactic sprays.

Agniastra Take 20 liters capacity earthen pot, add 10 litres of desi cow urine, add five kg of crushed green leaves of neem + 0.5 kg crushed green chilli + 0.5 kg crushed garlic. Now dissolve all this mixture in cow urine and boil it. After 3-4 boils, take it down from the fire. Let it cool for 48 hours and then filter the solution with a cloth. Now the solution is ready to spray on the crop. For insects living in tree trunks or stalks, all types of large bollworms and caterpillars' four litres of agniastra has to be dissolved in 200 litres of water and has to be sprayed at 20 ml agniastra per litre of water.

Brahmastra (broad spectrum botanical pesticide) for management of leaf roller, boll worm, pod borer and sucking pests : Take 20 liters capacity earthen pot add 10 liters of cow urine + 3 kg of crushed green neem leaves + 2 kg crushed karanj leaves + 2 kg crushed custard apple leaves + 2 kg crushed papaya leaves.+ 2 kg crushed

pomegranate leaves + 2 kg crushed guava leaves + 2 kg crushed Lantana camera weed leaves + 2 kg crushed Datura stramonium weed leaves . Now dissolve all this mixture in cow urine and boil it. After 3-4 boils, take it down from the fire. Let it cool for 48 hours and then filter the solution with a cloth. Now the solution is ready to spray on the crop. Four litres of brahmastra has to be dissolved in 200 litres of water and has to be sprayed at 20 ml brahmastra per litre of water.

d. Weed management practices

i. Name of the practice: Mulching (live mulching and straw mulching), passing cycle weeder and hand weeding

ii. Brief description of the practice : Mulching is an important practice in natural farming it involves covering the soil surface with decomposable materials or spreading type of leguminous crops as live mulch.

iii. Benefits of the practices (Impacts) :

a. Straw mulch plays a crucial role in weed management in natural farming by preventing weed seed germination. Additionally, it reduces soil moisture evaporation and decomposes over time to enhance soil fertility.
b. The spreading type of legumes effectively suppresses weed growth, while also contributing leaf litter that enriches the soil and boosts fertility.

iv. Protocols to be followed :

a. Apply 4 tonnes of well-dried straw per hectare between the rows of field crops, 25–30 days after sowing. For perennial trees, use approximately 5 kg of straw as mulch around the base of each tree.

b. Sow 7–10 kg per hectare of spreading leguminous crops such as cowpea, horse gram, or soybean between the rows of the main crop and around the base of trees. These crops produce abundant foliage, helping to suppress weeds and improve soil fertility.

c. In light textured soils cycle weeder can be passed. Now – a days power operated / solar operated cycle weeders are available in the market and can be utilized for effective weed management followed by better aeration to crops.

d. Age-old practice of hand weeding can be practiced for weed management and the uprooted weeds can be again used for mulching in between crop rows.

Fig.7. Mulching in basins to avoid weeds.

Fig.8. Live - mulching with pulses to avoid weeds.

e. Seed selection, treatment and sowing process

i. Name of the practice : Selection of local / desi varieties, Beejamrutha, use of seed drill for sowing, manual seed dibbling / transplanting

ii. Brief description of the practice : Farmers can select the bold, good filled, disese and pest-resistant, drought resistant seeds with their own expertise and experience. This helps in getting virulent and vigorous seedlings. Beejamrutha can be prepared at farmers level using desi cowdung and lime. Sowing is done using seed drill / dibbling of seeds / transplanting of seedlings.

iii. Benefits of the practices (Impacts):

- Selection of desi / local varieties ensures better response to applied jeevamrutha, ghanajeevamrutha.

- Seed treatment with beejamrutha ensures better germination, disease free, vigorous seedlings
- Manual dibbling of seeds / transplanting of seedlings ensures better germination, optimum plant population and optimum spacing for further growth and development of crops.
- Avoiding tractor for sowing avoids compaction of soil thereby soil microbes and structure of the soil is maintained.

iv. Protocols to be followed :

Beejamrutha : 5kg of desi cowdung is tied in cotton cloth and immersed in a bucket containing 20 litres of water with the help of stick. 50 grams of lime is dissolved in a mug of water. Next day in the morning the cowdung is squeezed along with cloth and is taken out. Water dissolved with lime is added to this and 5 litres of desi cow urine is added to this solution. One hand full of soil taken from field bunds is added to this solution. Now beejamrutha is ready. Seeds before sowing have to be immersed for one minute and then shade dried. Seedlings also has to be immersed for one minute before transplanting in the main field. In case of potato, sugarcane etc, the cut tubers can be immersed for one minute in beejamrutha and used for sowing.

Fig. 9. Beejamrutha preparation

Fig.10. Methodology of seed treatment with beejamrutha

f. Cropping systems

i. Name of the practice : Cereals - pulses, highly nutrient exhaustive crops – soil fertility restorative crops
Finger millet - field bean, Paddy – soybean, Pigeon pea + finger millet , Finger millet – cowpea, Paddy – green gram, sugarcane + soybean, cotton + field bean

ii. Brief description of the practice : Adopting a cereal-legume cropping system is highly recommended for enhancing soil health, optimizing nutrient utilization, and reducing the occurrence of weeds, pests and diseases. This system not only boosts economic returns but also promotes the growth of beneficial soil microflora, natural predators contributing to sustainable agricultural practices.

iii. Benefits of the practices (Impacts):

- Since legumes have the unique ability to fix atmospheric nitrogen through their symbiotic relationship with Rhizobium bacteria in their root nodules. This natural nitrogen enrichment reduces the dependence on chemical fertilizers and improves soil fertility for the subsequent cereal crop.
- The complementary nature of cereals and legumes often results in higher combined yields compared to cereal-cereal cropping system.
- Inclusion of pulses like cowpea, green gram, black gram, field bean in cropping system encourages the growth of natural enemies like lady bird beetles resulting in biological pest management.

- Growing of yellow flower crops like marigold, sesamum all along the borders will reduce the pest incidence on main crop, reduce the nematode problem in the soil.

iv. Protocols to be followed :
Cultivation of leguminous crop in the early monsoon seasons (May-June) and then sowing of cereal or millets in the monsoon season.

g. Water management practices

i. Name of the practice : Rainfed crop, trenches, mulching

ii. Brief description of the practice : Rainfed cropping, trench cultivation and mulching are integral practices in natural farming, aimed at ensuring sustainable agricultural productivity in water-scarce conditions. Rainfed cropping relies on rainfall, making it essential to adopt water-conservation methods to optimize moisture use. Protective irrigation is a strategic approach that involves providing minimal water during critical crop growth stages to prevent yield loss during dry spells. Mulching complements these practices by covering the soil with organic materials such as straw or live mulching, reducing moisture evaporation, suppressing weeds, and enhancing soil fertility. Together, these techniques create a resilient farming system that conserves resources, improves soil health and supports sustainable crop production.

iii. Benefits of the practices (Impacts) :
- Rainfed cropping maximizes the use of natural rainfall, reducing dependency on external water sources.
- Protective irrigation ensures minimal but critical water application during key growth stages, safeguarding crops during dry spells.
- Mulching suppresses weed growth and reduces soil evaporation, maintaining consistent soil moisture.

iv. Protocols to be followed : Sowing of the crop as a rainfed crop or sowing immediately after rainfall, followed by mulching which reduces the loss of soil moisture and protective irrigation to be provided during the dry spells or during critical stages of crop growth.

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Annexure- X

University of Agricultural Sciences, Dharwad, Karnataka

1. Natural Farming Practices:

a) Soil health management practices

i) **Name of the practices:** Minimum tillage, cover cropping and Mulching

ii) **Brief description of the practice:** The soil should not be reversed through Mould Board plough to keep the crop residues on the top of the soil to conserve soil moisture and to protect earth worms and General as well as beneficial micro flora. At the time sowing the soil should be tilled to the depth of 15 cm with the help of bullock drawn desi plough, harrowing and cultivator to make the required soil tilth for establishment of the crop.

iii) **Benefits of the practices (impacts):** Minimum soil disturbance and soil structure is maintained. Porosity increased due to less compaction by heavy tractors and trampling. Soil Bulk density reduced, Infiltration rate and water holding capacity increased. Checks soil erosion due to improved aggregate stability

iv) **Protocols to be followed :** Cultivate the soil with desi wooden or iron plough followed by harrowing and cultivator using bullock pairs as draft power at appropriate soil moisture

Cover the soil with cover crops or mulching with crop residues or green lopping materials during off season to protect the soil from high and intense sun light

Mulching can be done through soil mulch by frequent intercultiation using hoes during dry season, live mulch by growing smothering leguminous crops as intercropping and crop residue mulching using left over crop residues and green lopping grown on the bunds

b) Nutrient management practices:

i) **Name of the practices:** Application of Ghanajeevamrut, jeevamrut, Foliar application of Jeevamrutha, Saptha dhanya kashaya, cow urine and Vermiwash, Insitu Green manuring crop and Green leaf manuring

ii) **Brief description of the practice:** Application of ghan jeevamrut and jeevamrut to the soil. Foliar application of Jeevamrutha, Saptha dhanya kashaya, cow urine and Vermiwash at critical stages of the crop. Use of green manuring crop and crop residues as mulch

iii) **Benefits of the practices (impacts):** Application of ghan jeevamrut and jeevamrut to the soil to enhance the biological activities to enhance the microbial activities and decomposition of mulched material. Foliar application of Jeevamrutha, Saptha dhanya kashaya, cow urine and Vermiwash at critical stages of the crop will overcome the nutrient deficiencies and promote plant growth by stimulating plant growth physiologically. Use of green manuring crop and crop residues as mulch will protect the soil from exposing to sunlight, provide favorable atmosphere will enhance the microbial activities and dark conditions favor the earthworm activities

iv) **Protocols to be followed :** Application of ghan jeevamrut @ 1000 kg /ha in two equal splits at the time sowing and top dressing at 30 days after sowing. Application of Jeevamrutha @ 200 l/ acre or 500 l/ha at every 15 days interval for short duration crop (4 times for 60-90 days crop) and 21 days interval for long duration crop (5 times for 4months crop and 7-8 times for 180 days crop). Foliar application of Jeevamrutha @ 20% at vegetative, flower bud initiation, flowering and grain filling stage, Saptha dhanya kashaya @200/acre or 500 l/ha at grain filling stage, cow urine and Vermiwash @ 10 to 20% at flowering and grain filling stage (can be mixed with jeevamrut spray). Use of green manuring crop (Glyricidia or sun hemp and crop residues as mulch @ 5.0 tons /ha at 30 Days after sowing after intercultivation.

C) Pest and Disease management practices:

i) **Name of the practices:** beejamrut, Diversified cropping system, Neemastra, Agni astra, Bramhastra, Dashaparni, to control pests and Ginger asthra, Sour butter milk and Wild dung decoction to control diseases.

ii) **Brief description of the practice:** beejamrut for management of soil and seed born diseases. Diversification of the cropping system through

intercropping mixed and sequence cropping and perennial timber, fuel wood and fruit trees and leguminous trees on the bunds and borders.
Sucking pests are controlled by application of Neemastra, stem borers and defoliators by Agniastra and pod borers and fruit borers through Dashaparni. Ginger asthra and Sour butter milk and Wild dung decoction for control of the foliar diseases.

iii) **Benefits of the practices (impacts):**

beejamrut seed treatment will protect the seeds from soil and seed born diseases and trigger's the early vigor of the plants due to presence of growth promoting substances in beejamrut.

The diversification of the cropping system with perennial fruit, timber and other trees will encourage predators and parasitoids. The diversified ecosystem disturbs mass multiplication of single pest and reduces the pest load on crops especially in intercropping system due to its non host plants and differential host preference of the pests. Thick 3-4 rows of tall growing Border crops or barrier crops will prevent entry of air born pests like mites and thrips.

Use of Neemastra will control the sucking pests like aphids, jassids, thrips and mites and prevent multiplication rate of the sucking pests due to presence of alkaloids and other herbal constituents. Sometimes it will also acts as fungicides.

Agniastra used to manage the stem borers and defoliators. Bramhastra is used to manage the pod borers and defoliators. In addition it will also acts as growth regulators due to presence of cow urine and herbal concoctions

Dashaparni is substitute to both Agniastra and Bramhastra. It consists of all the ingredients used in Agniastra and Bramhastra and therefore effective against both pod borers, defoliators and other pests. Under severity of pest incidence both Agniastra and Bramhastra can be mixed together and sprayed will take care of all types of the pests. In addition to manage the pests these concoctions will also acts as growth promoters' due to presence of cow urine and other herbal constituents.

iv) **Protocols to be followed: Intercropping** is better than mono or sole crop. So the profitable intercropping systems such as Cotton + Ground nut (2:4),

Red gram + Ground nut (2:4), Red gram + Finger millet (2:4), Red gram+ Fox tail millet (2:4), Red gram+ Barn yard millet (2:4), Ground nut + Finger millet (4:2), Ground nut + Kodo millet (4:2), and Ground nut + Brown top millet (4:2) are recommended under natural farming practices.

Diversification of the cropping system can be done by growing Glyricidia and subabull as border and barrier crops. Further Teak, Neem Tamarind and Jamun trees are grown on the border bunds. Inside bunds are planted with Drumstick and other suitable fruit crops.

Beejamrut seed treatment @ 250 ml/kg seed or 100 kg seed in 25 liter beejamrut solution. The hard seed coat seeds are to be soaked in beejamrut for 8-10 minutes. It can be tied in porous cloth and immersed in water, then shade dry and take up sowing. The delicate seeds like soybean and Ground nut kernels should treated sprinkling on the seeds and spreading on the gunny bags. Shade dry and use for sowing. The treatment is to be done on the day of sowing by preparing beejamrut keeping over night.

Neemastra is to be prepared as per the protocol and sprayed @200 l/acre or 500/ hectare at 15-25 days after sowing (DAS) looking to the incidence of sucking pest.

Agni astra @ 3% (6 liter Agniastra in 200 water) is to be sprayed as prophylactic spray to control stem borers and defoliators whenever small holes or streaks are observed on the leaves coinciding around 30-35 DAS.

Bramhastra @ 3% (6 liter Agniastra in 200 liter of water) is to be sprayed as prophylactic spray to control defoliators and fruit or flower borers in sequence after Agniastra at 10-15 days interval.

Dashaparni @ 3% (6 liter Agniastra in 200 water) is to be sprayed to control pod borers, fruit or flower borers and defoliators and in sequence after Agniastra and Bramhastra at 10-15 days interval. Later if any pests observed mixed formulation of Agni astra @3 % + Bramhastra @ 3% is sprayed to control the aforesaid lepidopteron insects

Shunti or Ginger astra, Sour butter milk and kakkulinna kashaaya: In order to control the disease when ever foliar diseases are observed at flowering and pod filling stage the shunti astra is prepared and sprayed @200 l/acre (500/ /acre). Alternatively Sour butter milk @ 3% and kakkulinna

kashaaya (Wild dung concoction) or extract of Ghanajeevamrut is prepared and sprayed to control the fungal foliar diseases. These can also be mixed with any herbal pesticides mentioned above if both pest and diseases are observed on the plant

d) Weed management practices:

i) **Name of the practices:** Inter cultivation, Hand weeding and mulching.

ii) **Brief description of the practice:** Intercultivation with blade hoes, Hand weeding with sickle twice and mulching with green manuring crops lopping and crop residues.

iii) **Benefits of the practices (impacts):** Loosens the soil for better aeration, increased infiltration rate of water received through the rainfall, prevents competition from unwanted plants and mulching helps to prevent evaporation loss of water, checks the run of water, provides shade and shelter to microbes used through jeevamrut and earth worms. The mulched materials will also act a substrate for general micro flora, beneficial micro flora and fauna.

iv) **Protocols to be followed:** Intercultivation with blade hoes twice at 15-20 DAS and 30 DAS using bullock pair as draft power followed by hand weeding to remove the weeds present all along the rows and mulching to prevent further emergence of weeds.

e) Seed selection, treatment and sowing practices:

i) Name of the practices: High yielding varieties with resistant to pest and diseases released from UAS Dharwad, Seed treatment with beejamrut and seed drill sowing in row crops and dibbling in wide spaced crops viz., cotton and Red gram, transplanting in chilli.

ii) **Brief description of the practice:** The seed can be selected from good and healthy plants which are producing more number of pods/ plant or big sized healthy ear heads or fruits and bolls. Dried threshed and preserved with sieved Ash powder, dried neem leaves and pulses seeds are treated with castor oil. The seeds should be preserved in air tight containers. The open pollinated improved and high yielding varieties (HYV) are also recommended to use as seed materials. **beejamrut** seed treatment.

iii) Benefits of the practices (impacts): The HYV performed better than old varieties due to its foliar disease resistance. Viz., resistant to rust in soybean (Dsb 21, Dsb 23, and Dsb 34, wheat (UAS 347), resistant to early and late leaf spot in ground nut (Dh 256 and Dh 245) , moderately tolerant to pests and sterility mosaic virus in red gram (TS 3 R). They have high yielding ability and widely adoptable. The HYV varieties are carefully selected by introducing desirable genes tested over many years and across the different agro climatic zones and released after acceptance by the farmers and extension functionaries.

Beejamrut seed treatment will protect the seeds from soil and seed born diseases and trigger's the early vigor of the plants due to presence of growth promoting substances like IAA and GA in beejamrut. Seed sowing with the help of Bullock drawn seed drill will not compact the soil and the germination will be better, saves labor and complete the operation in less time

iv) Protocols to be followed:

Seed selection: The High yielding varieties with resistant to pest and diseases released from UAS Dharwad are recommended as per the seed rate prescribed for general cultivation of different crops. The certified or foundation seed classes are recommended to use because they are tested and viable and quality seeds are passed to sale as seed material.

Once seed is procured from the authenticated source, the farmers can maintain their own seed through proper selection procedure by selecting the true to type disease free health and bold seeded plants

beejamrut seed treatment @ 250ml /kg seed or 100 kg seed in 25 liter beejamrut. The hard seed coat seeds are to be soaked in beejamrut for 8-10 minutes. It can be tied in porous cloth and immersed in water, then shade dry and take up sowing. The delicate seeds like soybean and Ground nut kernels should treated sprinkling on the seeds and spreading on the gunny bags. Shade dry and use for sowing. The treatment is to be done on the day of sowing by preparing beejamrut keeping over night.

The spacing and seed rate for different crops are recommended as per the protocol of the UAS Dharwad package of practices for higher yields. The method of sowing is preferably bullock drawn seed drill at the recommended spacing to prevent trampling. Dibbling and transplanting in the wide row spaced crops viz., Cotton and chilli.

f) Cropping systems

i) Name of the practices: The diversification of the cropping system with sequence, intercropping, Border cropping and trap cropping.

ii) Brief description of the practice

Diversification of the existing cropping system with perennial fruit, timber, fodder, fuel wood and green manuring trees. **Intercropping** with two or more crops will overcome the risks of crop failure due to vagaries of the monsoon. Thick 3-4 rows of tall growing Border crops and trap crops or barrier crops will prevent entry of air born pests like mites and thrips.

iii) Benefits of the practices (impacts): Diversification of the cropping system with perennial fruit, timber, fodder, fuel wood and green manuring trees will supply all the requirements of the family livelihood and overcome the risks against climate change and vagaries of the monsoon.

Intercropping system will help full to utilize the natural resources like solar radiation, rainfall water or soil moisture, space and time efficiently and give better yield per unit area than their corresponding sole crops. Thick 3-4 rows of tall growing Border crops and trap crops or barrier crops will prevent entry of air born pests like mites and thrips. Perennial Green manuring crops will serve nutrients to the crop and can be used a mulching material.

iv) Protocols to be followed:

Intercropping is better than mono or sole crop. So the profitable intercropping systems such as Cotton + Ground nut (2:4), Red gram + Ground nut (2:4), Red gram + Finger millet (2:4), Red gram+ Fox tail millet (2:4), Red gram+ Barn yard millet (2:4), Ground nut + Finger millet (4:2), Ground nut + Kodo millet (4:2), and Ground nut + Brown top millet (4:2) are recommended under natural farming practices.

Diversification of the cropping system with perennial fruit trees Guava, Mango and Sapota at 30 ft distance on the bunds. Drumstick, papaya and Banana as intercrop in between fruit trees. Timber, fruit and fuel wood trees like Teak, tamarind, neem and silver oak on one or two sides of the border. Perennial Fodder and green manuring trees on other borders to meet out the fodder and green manure required.

Sequence crops like green gram-Rabi sorghum and soybean-wheat crops are recommended for northern dry zone) Zone 3) and Northern transitional zone of Karnataka (Zone 8).

v) Water management practices

i) **Name of the practices:** Protected life saving irrigation through sprinkler system Since zone 8 assured rainfall area

ii) **Brief description of the practice:** Sprinkler irrigation using bore well or farm pond water

iii) **Benefits of the practices (impacts):** Acts as a life saving irrigation whenever dry spell occurs and during rabi season to meet out the water requirement of the crops

iv) **Protocols to be followed:** When the rainfall is receded more than 20-25 days looking to the soil moisture conditions and plant health conditions sprinkler irrigation can be given to save the crop from drought and at critical stages in irrigated Rabi season crops.

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Annexure XI

Odisha University of Agriculture & Technology, Bhubaneswar, Odisha

1. Natural Farming practices

a. Soil health Management practices

- Name of the practices - Green manuring
  - Application of jeevamrut
  - Crop rotation with legumes
- Brief description of the practices
  – Growing of green manure crops Dhaincha and incorporated in soil at 40 DAS.
  – Application of jeevamrut @200 l per acre along with foliar spray @ 10 % solution
  – Cultivation of green gram after rice
- Benefits and detailed practices – It can improve the soil health by addition of organic matter to the soil. Application of jeevamrut can improve microbial activity in soil. Crop rotation with legumes restores the soil fertility through biological Nitrogen Fixation.

b. Nutrient Management practices

- Name of the practices
  - Application of FYM (On farm produce)
  - Application of organic matter through decomposition of organic mulch
  - Application of jeevamrut
- Brief description of the practices
  – FYM is produced in the farm itself and applied @ 5t/ha during the final land preparation
  - The organic mulching material like straw and leaves are added to the soil after decomposition and supplements to the soil nutrient pool
  - Application of jeevamrut @200 l per acre along with foliar spray @ 10 % solution
- Benefits and detailed practices – Organic source of nutrients is a very stable source and supply the nutrients to the plants as per its demand without any adverse effect on soil health.

c. Pest and Diseases Management practices

- Name of the practices
  - Application of Neemastra
  - Application of Brahamstra

- Application of Sour butter milk

- Brief description of the practices
  - Application of Neemastra and Brahmastra @ 4% spray at 15 days interval as a preventive pest care against sucking pests, borer etc .
  - Sour butter milk is applied as foliar spray @ 3l/100 l water against fungal diseases
- Benefits – It is purely organic base . It has no adverse effect on environment. Low cost attributes to reduction in cost of cultivation.

d. **Weed Management practices**
- Name of the practices
  – Mulching
  - Manual Weeding
  - Cover crops
- Brief description of the practices-
  - Application of organic mulch suppress the weeds
  - Intercropping with short duration crop acts as cover crops and manage the weeds
  - Need based manual weeding is done
- Benefits
  -Chemical free weed management practices
  - Low cost of weed management through cover crops /mulching

e. **Seed selection and treatment**
- Name of the practices
  – Quality seed
  - Seed treatment with beejamrut
- Brief description of the practices
  - Quality seeds of preferably indigenous variety are opted
  - Seed treatment with beejamrut @ 1 l/2 kg of seeds(Based on size of seeds, it is to ensure a thin coating of beejamirt over each seed)
- Benefits and detailed practices
  – Good germination
  - Better vigour and growth
  - Reduction in infestation of soil borne diseases

f. Cropping system followed
- Name of the practices
  – Kharif – Rice

- Rabi- Sole greengram, Brinjal+ Cowpea, Cowpea+pointed gourd, Okra + Guar

- Benefits - Increased resource use efficiency with reduction in risk

g. Water Management practices

- Name of the practices
  – Alternate furrow irrigation
  – Sprinkler irrigation
  – Mulching
- Brief description of the practices with benefits
  – Alternate furrow irrigation methods conserves irrigaqtion water and maintains whapsa condition.
  - Sprinkler irrigation methods also conserves water and energy
  - Mulching helps in conservation opfd soil moisture and reduces the number of irrigation by increasing irrigation interval

h. **Any other ITKs/practices followed**

– For storing of seeds neem leaves and begunia leaves are kept along with the stored seeds

- Cow urine is sprayed on the leaves to avoid damage from monkey and bulls.
- Yellow coloured earthen pot smeared with castor oil is used as insect traps for sucking pests.

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Annexure- XII

Punjab Agricultural University, Ludhiana, Punjab

1. **Natural Farming practices**

a. Soil health management practices

i. Name of the practice: Natural farming involves four core practices: NFCs (beejamrut, ghan jeevamrut and jeevamrut), crop residue mulching, intercropping and promoting soil aeration (Whapasa)are used for soil health management and pre-kharif green manuring with multiple crops.

ii. Brief description of the practice:

NFCs are microbial formulations used in natural farming to enhance soil health. beejamrut treats seeds, while ghan jeevamrut (1000 kg/ha) is applied as organic manure before sowing, and jeevamrut (500 liters/ha) is applied with irrigation or as a foliar spray to boost microbial activity and nutrient availability.

Mulching with crop residues or paddy straw reduces erosion, moisture loss, and improves soil fertility. Intercropping with legumes enhances nitrogen fixation and supports crop growth.

Whapasa refers to maintaining the balance of air and water in soil pores, promoting healthy root development and nutrient uptake.

Pre-kharif green manuring with crops like pearl millet, sorghum and sunhemp improves soil fertility and structure through nitrogen fixation and organic matter addition.

Preparation procedure of NFCs

1. **beejamrut**

   Take 5 kg of indigenous cow dung (preferably fresh or not more than 3 days old) in a cloth and bound it by tape and hang this in the 20 liters of water for 12 hoursTake one liter water and add 50 g lime in it, keep for a nightSqueeze this bundle of the cow dung in water 3 times to extract materialAdd the soil from undisturbed bunds or forest or under tree cover in the solution and stir it well Add 5 liters of indigenous cow urine in the solution & add the lime water and stir it well. beejamrut is ready to treat the seeds

2. **jeevamrut**

   In a plastic drum of 250 litres capacity, add 10 kg of fresh cow (indigenous) dung, 10 litres of indigenous cow urine, 2 kg of Jaggary, 2 kg of pulse flour (Basan, Chickpea

flour) and 150 g of soil from undisturbed bunds or forest or under tree cover in 200 litres of water and mix thoroughly. Keep the drum in shade covering with gunny bag or cotton cloth or plastic mosquito net. Stir the mixture for 5-10 minutes for twice a day (morning and evening) with wooden stick. jeevamrut is ready for application at 9th day and it can be applied up to 12th day from its preparation.

3. **ghan jeevamrut**

ghan jeevamrut was prepared by mixing 100 kg indigenous cow dung (4 to 5 days old), 1 kg chickpea flour, 1 kg jaggery, 3 litres cow urine and 250 g undisturbed virgin soil collected from canal bank. It was then kept for 10 days under shade away from direct sunlight and then applied in the field @ 1000 kg/ha before sowing.

iii. Benefits of the practices (Impacts):

Jeevamrut and ghan jeevamrut enhance the availability of essential nutrients and support the growth of beneficial microorganisms, including bacteria, fungi and actinomycetes, in the soil. These microbial formulations improve soil fertility by increasing biological activity and mineralizing nutrients from unavailable to available forms. jeevamrut, rich in plant growth hormones, stimulates microbial activity, leading to enhanced nutrient cycling and improved soil health when applied through irrigation water or foliar spray. ghan jeevamrut , the solid form of jeevamrut, provides similar benefits but in a more concentrated form, further promoting soil fertility and microbial diversity.

The retention of crop residues or the application of paddy straw as mulch offers several agronomic benefits. It helps protect the soil from erosion, reduces moisture loss through evaporation, and improves the organic matter content over time, contributing to better soil structure and enhanced fertility. This practice also fosters increased soil microbial activity, supporting long-term soil health.

Intercropping with legumes not only aids in nitrogen fixation, improving soil fertility, but also contributes to weed management by reducing weed competition. When legumes are intercropped with cereal crops, nitrogen is directly transferred from the legume to the cereal, enhancing the nitrogen nutrition of the cereal crop. This synergistic relationship boosts crop yields and promotes sustainable farming practices.

Whapasa, the balance of air and water in the soil's pore space, is a key concept in sustainable agriculture. By optimizing this balance, crops benefit from better root

respiration and nutrient uptake, reducing the risk of waterlogging and ensuring efficient water use.

Pre-kharif green manuring involves the use of a mixture of nine crops—pearl millet, sorghum, cowpea, greengram, marigold, clusterbean, sesame, sesbania and sunhemp. These crops are grown to enhance soil fertility through nitrogen fixation, organic matter addition, and the creation of a favorable soil environment for subsequent crops. Green manuring improves soil structure, microbial diversity, and nutrient availability, promoting sustainable agricultural practices.

iv.Protocols to be followed: Protocol prepared by ICAR-IIFSR, Modipuram, Meerut, UP under All India Network Programme on Organic Farming (AI-NPOF) for Natural Farming experiments.

b. Nutrient management practices

i. Name of the practice: Natural farming involves four core practices: NFCs (beejamrut, ghan jeevamrut and jeevamrut) and intercropping are used for nutrient management in NF along with some other liquid organic manures like vermiwash, cowurine, cow dung cake extract etc.

ii. Brief description of the practice:

NFCs are microbial formulations primarily used in natural farming. ghan jeevamrut is applied as an organic manure at a rate of 1000 kg/ha before sowing, while jeevamrut is applied at 500 liters/ha either through irrigation water or as a foliar spray.Intercropping with legumes like cowpea enhance soil health through biological nitrogen fixation.

Vermiwash is a liquid organic manure derived from the excretory products and excess secretions of earthworms, enriched with micronutrients and organic molecules from the soil.

Cow dung cake extract used as foliar application for various agricultural purposes since ancient times, plays a crucial role in crop growth.

iii. Benefits of the practices (Impacts):

jeevamrut and ghan jeevamrut accelerate nutrient availability in the soil by supplying essential nutrients, plant growth hormones, and enhancing soil biological

activity.ghan jeevamrut , the solid form of jeevamrut, provides similar benefits but in a concentrated, stable form. jeevamrut promotes microbial activity, which helps in mineralizing nutrients from unavailable forms into available forms. When applied with irrigation water or through foliar spray, the consortium of beneficial microorganisms in jeevamrut supports soil fertility improvement and nutrient mobilization.

Intercropping with legumes like cowpea enhance soil health through biological nitrogen fixation, which improves soil nutrient availability, reduces the need for synthetic fertilizers, and supports sustainable cropping systems. These integrated practices are effective components of conservation agriculture and agroecological farming systems, promoting both productivity and ecological balance.

Vermiwash contains water-soluble nutrients and provides immediate nutrient availability for crops. It also contains enzymes, earthworm secretions, soluble plant nutrients and organic acids that stimulate growth and improve yields. Crops treated with vermiwash exhibit enhanced resistance to insects, pests, and diseases, due to the presence of beneficial microorganisms that protect the plants from infestations and promote growth.

Cow dung cake extract has been used for centuries as a vital input in agriculture. It contains humic compounds, essential nutrients and bioelements that support crop growth. Cow dung cake extract is a rich source of bio-fertilizers and natural pest repellents, enhancing soil fertility and microbial populations, thereby improving soil health and boosting agricultural productivity.

iv. **Protocols to be followed:** Protocol prepared by ICAR-IIFSR, Modipuram, Meerut, UP under All India Network Programme on Organic Farming (AI-NPOF) for Natural Farming experiments.

c. Pest and Disease management practices

i. **Name of the practice:**beejamrut protects seeds and seedlings from diseases. Biopesticides like Neemastra, Agniastra, Brahmastra, Dashparniand sour better milk used to manage pest and diseases. Okra and marigold are used as trap crops in natural farming.

ii. **Brief description of the practice:** beejamrut is used to treat seeds, seedling roots, and other planting materials, protecting crops from soil- and seed-borne diseases that commonly affect plant health. Biopesticides such as Neemastra, Agniastra, Brahmastra and Dashparni are applied to manage insect pests effectively.

Additionally, trap crops like okra and marigold are utilized in natural farming to attract pests away from the main crops, providing an integrated approach to pest management.

Preparations of Biopesticides

1. **Neemashtra**
   Neemashtra is a neem and cow urine based liquid formulation. Take 5 kg of fresh neem leaves or 5 kg of neem seed kernels (3-8month old) crush the materials to make fine/small pieces. Mix the crushed leaves/kernels in 100 litres of water in a plastic drum. Mix 5 litres of indigenous cow urine and 1kg of indigenous cow dung. Mix the content thoroughly with the help of a wooden stick for 2-3 minutes. Cover the mouth of drum with a fine cotton cloth and incubate for 48 hours. Stir the content thrice a day for 2-3 minutes After 48 hours, filter the content with a fine mesh or cloth and spray on one acre crop.

2. **Agniastra**
   Agniashtra is a botanical formulation prepared by using neem leaves, chilli fruits, garlic and cow urine. Take half kg each of green chilli and garlic and 5 kg of fresh neem leaves. Crush all the three materials to make a fine paste. Add crushed materials in 20 litres of indigenous cow urine and mix it thoroughly. Boil the content with intermittent stirring with wooden stick for about 20 minutes. Cool the content for about 48 hours. Filter the content with fine cotton cloth. Take 5-6 L of filtrate and dilute in 250 L of water for spraying on one ha crop.

3. **Brahmashtra**
   It is a cow urine and botanicals-based formulation. Take 3kg of fresh neem leaves and 2 kg of karanj (Pongamia pinnata) leaves. If karanj leaves are not available, take 5 kg of neem leaves and crush then to fine pieces. Take 2 kg of custard apple leaves and 2 kg of Datura leaves and crush them to fine pieces. Mix all the above crushed leaves in 10 litres of indigenous cow urine. Boil the mixture for about 20-25 minutes. Cool the mixture for 48 hours. Filter the content with fine cotton cloth. Take 5-6 litres of filtrate and dilute in 250 litres of water for spraying on one ha.

4. **Dashparni**
   Take 5kg of neem leaves and 2 kg leaves, each of any ten plant species. Take 10 litres of indigenous cow urine, 10kg indigenous cow dung, 500-gram turmeric powder, 500-gram garlic paste, 500 grams ginger paste, 1kg tobacco leaf powder, 1kg hot chilli paste. Crush the leaves to fine pieces. Protocol for preparation of inputs for Natural Farming experiment under AI-NPOFMix all above ingredients in

200 litres water drum in shade. Shake the mixture thrice a day with the help of a wooden rod and ferment the content for 30-40 days. Filter the content with fine cotton clothStore the filtrate in containers and it can be used for 6 months.

iii. Benefits of the practices (Impacts):

Fresh neemashtra issprayed on crops to control insect-pests like aphids, jassids, mealy bugs, thrips, whiteflies,small caterpillars and other sucking pests. For spraying, one hectare of crop, 250 litres ofsolution is required.

Agniashtra is used to manage stem borers, fruit borers and other different types ofcaterpillars of the crop. Five to six litres of Agniashtra is sufficient for spraying in one hectareof crop after dilution in 250 litres of water.

Brahmashtra is used to manage large size borers and caterpillars of the crops. Fiveto six litres of brahmastra is sufficient for spraying in one hectare of crop after dilution in 250litres of water.

Dashparni extract is useful to manage all kind of insect-pests of crops and orchards.Take 5-6 litres of dashparni extract and dilute in 250 litres of water for spraying on one hacrop.

iv. Protocols to be followed: Protocol prepared by ICAR-IIFSR, Modipuram, Meerut, UP under All India Network Programme on Organic Farming (AI-NPOF) for Natural Farming experiments.

d. Weed management practices

i. Name of the practice: Intercropping, Mulching, Mechanical weeding

ii. Brief description of the practice: The retention of crop residues on the soil surface or the use of paddy straw as mulch helps in weed suppression, protect the soil and conserve moisture. Additionally, intercropping with legumes such as cowpea, a cover crop, effectively suppresses weeds by shading the ground and blocking sunlight. Mechanical weed management by different field implements by reshaping of the beds.

iii. Benefits of the practices (Impacts): Mulching acts as a physical barrier, significantly suppressing weed germination and growth by limiting their access to sunlight and reducing temperature fluctuations on the soil surface.Additionally, intercropping with legumes such as cowpea, a highly effective cover crop, further

contributes to weed suppression. Cowpea forms a dense canopy that shades the ground, blocking sunlight and creating an environment unfavourable for weed germination. Furthermore, legumes like cowpea enhance soil health through biological nitrogen fixation, which improves soil nutrient availability, reduces the need for synthetic fertilizers, and supports sustainable cropping systems. These integrated practices are effective components of conservation agriculture and agroecological farming systems, promoting both productivity and ecological balance.

Mechanical weed management through the use of various field implements, combined with the reshaping of beds, is an effective strategy for reducing weed pressure in agricultural systems. Field implements such as rotary hoes, harrows, cultivators, and tine weeders are commonly used to physically disrupt weeds at various growth stages, particularly in the early stages of crop development.Overall, mechanical weed management, when integrated with bed reshaping and other cultural practices, supports sustainable weed control by reducing reliance on chemical herbicides and promoting healthier crop growth environments.

iv. Protocols to be followed: Protocol prepared by ICAR-IIFSR, Modipuram, Meerut, UP under All India Network Programme on Organic Farming (AI-NPOF) for Natural Farming experiments.

e. Seed selection, treatment and sowing practices

i. Name of the practice:
Traditional varietal seeds, seed treatment with beejamrut.
Sowing is done on furrows, raised beds, or broad beds to maintain Whapasa.

ii. Brief description of the practice: Only traditional or indigenous varietal seeds are used, avoiding the use of genetically modified (GMO) or hybrid seeds to maintain biodiversity and ecological balance. Before sowing, the seeds are treated with beejamrut, a natural seed treatment solution prepared from cow dung, cow urine, lime and water.

The concept of Whapasa in natural farming emphasizes maintaining an optimal balance of air and water in the soil's pore spaces. This is achieved through practices such as alternate furrow irrigation, where only the open furrows receive water while the ends of alternate furrows are closed to prevent over-irrigation.

iii. Benefits of the practices (Impacts): Beejamrut is used for treatment of seed, seedling roots or other planting material. beejamrut helps protect seeds from

pathogens, enhances germination, and promotes the growth of beneficial soil microbes.

Whapasa, the optimal balance of air and water in soil pores, promoting healthy root growth and efficient irrigation.This technique reduces water wastage, improves root aeration, and minimizes the risk of waterlogging, thereby creating favorable conditions for plant growth. By combining these traditional practices, natural farming ensures sustainable and eco-friendly agricultural productivity.

iv. Protocols to be followed: Protocol prepared by ICAR-IIFSR, Modipuram, Meerut, UP under All India Network Programme on Organic Farming (AI-NPOF) for Natural Farming experiments.

e. Cropping systems

i. Name of the practice: Maize-Wheat
Rice- Wheat
Maize + Cowpea – Wheat+Chickpea
Baby corn – Chickpea – Summer moong
Sesame – Chickpea

ii. Brief description of the practice: In the maize-wheat system, maize is sown as a kharif crop and wheat as a rabi crop on furrows or raised beds to optimize growth. In the maize + cowpea and wheat + chickpea intercropping system, legumes enhance soil fertility, provide extra income and improve soil health.

iii. Benefits of the practices (Impacts): In the maize-wheat cropping system, maize is cultivated as a kharif crop and wheat as a rabi crop, leveraging furrows, raised beds, or broad beds to optimize growth conditions. These methods improve soil aeration, enhance root penetration and minimize waterlogging, ensuring efficient nutrient uptake and moisture retention.

In the second cropping system, maize + cowpea during kharif and wheat + chickpea during rabi are implemented as intercropping systems. Intercropping cowpea and chickpea provide multiple benefits, including additional income, enhanced soil fertility through biological nitrogen fixation and improved soil structure due to the varied root systems. Raised beds and furrows further optimize water use efficiency, support better crop establishment, and reduce competition between crops.

These cropping systems enhance resource use efficiency, suppress weeds, and diversify income sources, making them economically and ecologically sustainable while promoting long-term soil health.

iv. Protocols to be followed: Protocol prepared by ICAR-IIFSR, Modipuram, Meerut, UP under All India Network Programme on Organic Farming (AI-NPOF) for Natural Farming experiments.

g. Water management practices

i. Name of the practice: Whapasa, the optimal balance of air and water in soil pores, promoting healthy root growth and efficient irrigation.

ii. Brief description of the practice: Whapasa, the optimal balance of air and water in soil pores, promoting healthy root growth and efficient irrigation. The concept of Whapasa in natural farming emphasizes maintaining an optimal balance of air and water in the soil's pore spaces. This is achieved through practices such as alternate furrow irrigation, where only the open furrows receive water while the ends of alternate furrows are closed to prevent over-irrigation.

iii. Benefits of the practices (Impacts): This technique reduces water wastage, improves root aeration, and minimizes the risk of waterlogging, thereby creating favourable conditions for plant growth. By combining these traditional practices, natural farming ensures sustainable and eco-friendly agricultural productivity.

iv. Protocols to be followed: Protocol prepared by ICAR-IIFSR, Modipuram, Meerut, UP under All India Network Programme on Organic Farming (AI-NPOF) for Natural Farming experiments.

h. Any other practices being followed

Most of the farmers adopt natural farming and its component in with integration of organic farming.

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Annexure- XIII

Maharana Pratap University of Agriculture & Technology (MPUAT), Udaipur, Rajasthan

Natural Farming practices

Cropping systems: Kharif: Groundnut + Sesame intercropping (4:2)

Rabi: Fennel + Cabbage intercropping (2:1)

a. Soil health management practices

i. Name of the practice: ghan jeevamrut + jeevamrut and multiple crops in summer

ii. Brief description of the practice: Application of ghan jeevamrut @250 kg/ha + jeevamrut @ 500 lit/ha/Twice a month (with irrigation or spray on soil as per rainfall availability).

In summer season, multi-crops (Maize, blacgram, greengram, sorghum, clusterbean, cowpea, sesame) should be sown.

iii. Benefits of the practices (impacts): Application of ghan jeevamrut @250 kg/ha + jeevamrut @ 500 lit/ha/Twice a month recorded higher groundnut equivalent yield (450 kg/ha) in kharif and fennel equivalent yield (2765 kg/ha) in rabi as compare to control in groundnut + sesame intercropping and fennel + cabbage intercropping, respectively.

iv. Protocols to be followed:
ghan jeevamrut : Take 100 kg indeginous cow dung and spread it on clean floor. Add 1 kg of jiggery + 1 kg pulse flour + 3 lit cow urine and 250 g soil from undisturbed bund or under tree cover to cow dung. After 10 days, ghan jeevamrut is ready for application.

jeevamrut: 200 litres of water was put in a barrel; 10 kg of fresh desi cow dung was added followed by 10 litres of aged cow's urine; To this 2 kg of jaggery, 2 kg of pulse flour (gram) and a handful of live soil from under canopy of the banyan tree (about 100 g) are added. Stir the solution well and let it ferment for 48 hours

in the shade. Now jeevamrut is ready for application. 200 litres of jeevamrut is sufficient for one acre of land

b. Nutrient management practices

i. Name of the practice: ghan jeevamrut + jeevamrut
ii. Brief description of the practice: Application of ghan jeevamrut @250 kg/ha + jeevamrut @ 500 lit/ha/Twice a month (with irrigation or spray on soil as per rainfall availability)

iii. Benefits of the practices (impacts): Application of ghan jeevamrut @250 kg/ha + jeevamrut @ 500 lit/ha/Twice a month recorded higher groundnut equivalent yield (450 kg/ha) in kharif and fennel equivalent yield (2765 kg/ha) in rabi as compare to control in groundnut + sesame intercropping and fennel + cabbage intercropping, respectively.

iv. Protocols to be followed:
ghan jeevamrut @250 kg/ha should be applied before sowing jeevamrut @ 500 lit/ha/Twice a month (with irrigation or spray on soil as per rainfall availability) should be applied.

c. Pest and Disease management practices

i. Name of the practice: Neemaster, Dashparni ark, Brahmaster, Neem seed kernel extract, border crop and trap crop

ii. Brief description of the practice: Application of Neemaster (10%), Dashparni ark (10%), Brahmaster (5%), border crop and trap crop, (Marrigold and tulsi at space between replication and subabul at outside border)

iii. Benefits of the practices (impacts): Application of Neemaster (10%), Dashparniark (10%) and Brahmaster (5%) recorded higher pest and disease control as compare to control in Groundnut + Sesame intercropping and Fennel + Cabbage intercropping.

iv. Protocols to be followed:

Neemaster: Add the 5 Litres of Cow's Urine to the 100 Litres of Water.Add the 5 Kgs of Cow Dung to the water as well.Crush the 5 Kgs of Neem Leaves to the

water.Allow this solution to ferment for 24 hours. Stir the solution twice a day by using a stick.Filter the solution using a cloth and use it.

Dashparni ark: Crush neem leaves 5 kg, aak leaves 2 kg, babool leaves 2 kg, papaya leaves 2 kg, tulsi leaves 2 kg, Custard apple leaves 2 kg, Karanja leaves 2 kg, Castor leaves 2 kg, Nerium 2 kg, dhatura leaves 2 kg, Green chilli paste 0.5 kg, Garlic paste 0.5 kg, turmeric paste 0.5 kg, ginger paste 0.5 kg, tobacco leaves 1 kg, Cow dung 5 kg and cow urine 5 lit in 200 lit water and ferment for 40 days. Shake regularly three times a day. Extract after crushing and filtering. The extract can be stored up to 6 months and is sufficient for one acre.

Brahmaster: Take 10 liters of desi cow urine. Add 3kg Neem leaves extract , 2 kg Custard apple leaves extract, 2 kg pongamia leaves extract, 2 kg of Beal leaves extract, 2 kg Castor leaves extract, 2 kg Datura leaves extract in it. Then boil this solution, keep the solution stable for 48 hrs after boiling. Then filter the solution and store it. Spray prepared Brahmastra on the crops to control all the sucking pests, pod borer, fruit borer, etc. For spraying take 5 liters in 100 liters of water. Brahmastra solution can be stored for 6 months. Border crop and trap crop, (Marrigold and tulsi at space between replication and subabul at outside border) should be grown.

d. Weed management practices

i. Name of the practice: Crop residue mulching

ii. Brief description of the practice: Crop residue mulching (Fennel stover in kharif and Groundnut + sesame straw + cabbage stover/leaves in rabi @ 5 t/ha)

iii. Benefits of the practices (impacts): Application of crop residue mulching reduce the weed intensity of different weeds such as *Portulaca, Amaranthus viridis, Digitaria sanguinalis, Echinochloa crus-galli, Chenopodium album, Chenopodium murale, Anagallis arvensis* etc.

iv. Protocols to be followed:
Fennel stover in kharif @ 5t/ha should be applied
Groundnut + sesame straw + cabbage stover/leaves in rabi @ 5 t/ha should be applied

e. Seed selection, treatment and sowing practices

i. Name of the practice: beejamrut

ii. Brief description of the practice: beejamrut should be treated with beejamrut in such a way that each seed should be wetted

iii. Benefits of the practices (impacts): Seed treatment with beejamrut gave higher yield as compare to control.

iv. Protocols to be followed: Take 20 liter Water, 5 Kg Local Cow Dung, 5 liter Local Cow Urine, 50 Gram Lime & Handful soil from the bund of the farm. Take 5 Kg Local Cow Dung in a cloth and bound it by tape. Hang this in the 20 Liter water for up to 12 hours. Take one liter water and add 50 gm lime in it, let it stable for a night. Then next morning, squeeze this bundle of the cow dung in that water thrice continuously, so that all essence of cow dung will accumulate in that water. Then add a handful of soil in that water solution and stir it well. Then add 5 liter Deshi cow urine or human urine in that solution & add the lime water and stir it well. Now beejamrut is ready to use.

f. Cropping systems

Kharif: Groundnut + Sesame intercropping (4:2)
Rabi: Fennel + Cabbage intercropping (2:1)

g. Water management practices

i. Name of the practice: Whapasa

ii. Brief description of the practice: Whapasa (irrigation in alternate furrows at noon)

iii. Benefits of the practices (impacts): Water management

iv. Protocols to be followed: Irrigation should be done in alternate furrows at noon

Annexure- XIV

Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh

Natural farming package of practices

1. **Natural farming package of practices:**

A. Soil health management practices	
i. Name of the practice:	Reduced tillage, Crop diversification, Crop rotation, Residue recycling, Cover crop
ii. Brief description of the practice:	● Cultivation of crops of diverse groups (cereals, pulses, oilseed and millets); special focus on integrating legumes in the cropping system. ● Minimum/reduced tillage to ensure proper germination and avoid the unnecessary tillage operations and expenditures ● Reside retention as mulch to reduce nutrient losses and enhance soil physical, chemical and biological activities. ● Integration of cover crops like Moong and cowpea in cropping sequences to reduce nutrient losses and weed growth and enhancing in-situ rainwater harvesting
iii. Benefits of the practices (impacts):	● Reduced soil compaction, nutrient losses ● Improve soil nutrient bioavailability, their acquisition and carbon sequestration ● Break insect/pest cycle ● Improve water conservation and productivity ● Reduce cost of cultivation, fuel consumption, environmental footprint and market dependency
iv. Protocols to be followed:	● Include pulses leguminous crops like groundnut, moong, cow pea, chickpea etc. in crop rotation to build soil health ● Adopt minimum tillage with 30-40% crop residue retention to cover soil surface
B. Nutrient management practices	
i. Name of the practice:	Ghanajeevamrut, jeevamrut, Panchgavya, cow dung-urine slurry
ii. Brief description	● Ghana jeevamrut (solid organic fertilizer) and jeevamrut (organic liquid fertilizers) made from cow dung, jaggery, flour, soil, and cow urine.

of the practice:	● jeevamrut: all the ingredients are mixed in the drum, churned twice a day and not allowed to be exposed to sunlight and rain water. Product is ready to use in 2-4 days. ● Ghana jeevamrrutha: Spread 200 kg of cow dung in an even layer and add 20 litres of liquid Jeevamrutham to the manure and mix well. Cover the heap with gunny bag and left for fermentation followed. Spread out on the ground and collect the dry manure for basal and top dressing. ● Cow dung-urine slurry: Collect the cow dung and urine is a tank. Allow the mixture get fermented anaerobically. Fermented product can be spread in the field with irrigation water after 15-20 days.
iii. Benefits of the practices (impacts):	● Fermented microbial cultures provides nutrients and promote the microbial and earthworm growth in the soil. ● Undisturbed soil added these products multiply the native species of microbes and organisms. ● Yield is higher in terms of both quantity and quality ● Reduce fertilizer load and environmental pollution ● Jeevamrutha also helps to prevent fungal and bacterial plant diseases. ● Reduce GHGs emissions and nutrient losses
iv. Protocols to be followed:	● Prepare the microbe enriched bio composites using locally available resources ● Apply Ghana jeevamrut @ 200-400 kg/acre at the time of sowing and at crucial stages (20-25 and 40-45 days after planting) ● Apply jeevamrut @ 200 – 400 litre/acre during growth period of 25 to 60 days, 2-3 times
C. Pest and Disease management practices	
i. Name of the practice:	Neemastra, Agniastra, Brahmastra
ii. Brief description of the practice:	● Neemastra: preparation of Neemastra using green/dry leaves or fruits, cow urine and cow dung. All the ingredients are mixed thoroughly and churned clockwise direction twice a day and cover with a cloth for 2 days. Allow all the all the alkaloids of neem to get dissolved and strain it and spray it on plants. ● Agniastra: Cow urine, tobacco leaves paste, neem leaves paste, green chilli paste and garlic paste are boiled covered with lid. 2-3% solution of cooled contents after 2 days is recommended for the foliar spray.

	● Brahmastra: Cow urine, chopped neem vantages and leaves paste, Karanj leaves paste, custard apple leaves paste, Castor leaves paste, Datura leave paste, Mango leaves paste are mixed thoroughly and boiled for an hour. Churn the boiled solution twice a day (morning and evening) till two days. 2-3% solution is ready for the application on standing crop.
iii. Benefits of the practices (impacts):	● Controls the sucking pests, caterpillars. ● Reduce pesticide load and ecological toxicity ● Conserve and promote the growth of beneficial insect and natural biocontrol agents ● Quality food for human consumption
iv. Protocols to be followed:	Application for Neemastra against sucking pests and early instar larvae at 30-45 days crop duration. Application of Agniastra and Brahmastra 3-5%
D. Weed management practices	
i. Name of the practice:	Mulching, cover cropping, hand weeding
ii. Brief description of the practice:	● Residue of previous crop is utilized as mulch for to suppress the weed emergence. ● Cover crops act as a live mulch which reduce the weed growth. ● Manual weeding at 20-25 days after swing the eliminate the crop-weed competition
iii. Benefits of the practices (impacts):	● Reduces weed growth and promote plant growth and development ● Improved soil fertility, water conservation, reduce water and nutrient losses ● Reduce chemical load and ecological toxicity ● Enhance productivity and profitability and reduce cost of cultivation ● Conserve and promote the growth of beneficial insect and natural biocontrol agents
iv. Protocols to be followed:	30 – 40% crop residue retention at 3-5 as mulch to prevent weed emergence and their growth
E. Seed selection, treatment and sowing practices	
i. Name of the practice:	Selection of short duration varieties preferably local seeds; Seed treatment with beejamrut; line sowing of treated seeds (seed drill)
ii. Brief description	● Identification and cultivation of local seeds of prominent crops which are well acclimatized and suitable for regional climatic conditions

of the practice:	● beejamrut: Mixture of cow dung, cow urine, lime and soil; potential natural fungicide and an anti-bacterial liquid to protect and elevate the seed germination. ● Line sowing with seed drill to mechanize the natural farming, labour and resource saving. ● Screening of promising varieties of groundnut, cowpea, moong, millets, wheat, chickpea, mustard is in the process
iii. Benefits of the practices (impacts):	● beejamrut protects young roots from pathogens, soil-borne and seedborne diseases that damage the plants at early stages particularly after the monsoon period. ● Better germination and seedling vigour ● Optimum plant population and crop stand ● Improved productivity and resource conservation
iv. Protocols to be followed:	● Sowing of seed treated with beejamrut. ● Prefer crops suitable for particular climate (Bundelkhand) and local seeds of groundnut, wheat, mustard, chickpea etc. ● Line sowing with seed drill to mechanize the natural farming, labour and resource saving.
F. Cropping systems	
i. Name of the practice:	Groundnut-wheat, Groundnut-mustard, Barnyard millet - chickpea, Cowpea-pea and Mung-mustard
ii. Brief description of the practice:	● Cultivation of prominent cropping systems of Bundelkhand viz., Groundnut-wheat, Groundnut-mustard, Barnyard millet - chickpea, Cowpea-pea and Mung-mustard ● Inclusion of legume (groundnut, cowpea, moong, chickpea, pea) in each cropping system/rotation
iii. Benefits of the practices (impacts):	● Impart biodiversity and climate resilience ● Biological soil tillage and nutrient cycling ● Improved soil fertility, nutrient availability, biological activity, carbon sequestration and overall soil health ● Improve resource use efficiency and water conservation
iv. Protocols to be followed:	● Prefer suitable crops for particular climate (Bundelkhand: kharif season – groundnut, millets, cowpea, moong; rabi season – wheat, mustard, chickpea, pea). ● Must include the legume in the cropping system. ● Vegetable based cropping system to assure higher farm productivity and profitability.
G. Water management practices	

i. Name of the practice:	Mulching, reduced tillage, cover cropping, low water requiring crops
ii. Brief description of the practice:	● Cultivation of low water requires crops under reduced tillage with residue mulching. ● Planting on optimum spacing with balanced crop density to reduce water evaporation.
iii. Benefits of the practices (impacts):	● Increase in-situ rainwater harvesting and reduce runoff losses ● Reduce evaporation, weed growth and thereby enhance crop productivity. ● Enhanced soil health, carbon sequestration and nutrient availability ● Ecological diversity inhibits the prevalence of crop associated weeds and insect-pests ● Improve resource use efficiency.
iv. Protocols to be followed:	Ensure the residue mulching and follow reduced tillage in prominent cropping systems

H. Any other practices being followed

- Plantation of timber trees (Teak) on the bunds (western direction – to avoid shading effect) for one-time assured income
- Plantation of moringa as perineal fodder and vegetable (northern or eastern direction)
- Cultivation of seasonal vegetables along with field crops for income diversification, nutritional security and risk management
- Short stature fruits (Custard Apple, Dragon Fruit, Guava, Sweet Orange, Ber, Papaya etc.) in northern or south direction for seasonal income and nutritional security
- Include perennial peritonea for seasonal income and nutrient ion security for farm families.

Annexure- XV

Gurukul, Kurukshetra, Haryana

Farm practices required to be included in protocol for conducting trainings and research on natural farming :

(A) All the farm practices which help in nurturing & multiplication of soil biota such as:

1. **Desi/native cow:** Preference should be given to cow dung and cow urine of native cow available in the area, however, comparative studies may be undertaken with other animal breeds for alternate options. Cows are hardly available in high altitude temperate areas like Ladakh and Jammu and Kashmir. In such cases, the experiments may be conducted on locally available animals like goats and sheeps.

2. **Zero/minimum tillage:** Adoption of tillage practices particularly in hot summer months is one of the biggest threats to soil organic carbon. Efforts should be made to minimise the tillage practices.

3. **Mulching**: Emphasis should be laid on residue and live mulching.

4. **Combination of natural farming, plastic mulching and drip irrigation**: Mulching is one of the inevitable components of natural farming. Crop residues for mulching are hardly available in rainfed areas and dry regions of the country like Badhmer and Jodhpur areas of Rajasthan, Kutch and Bhuj areas of Gujarat, Bundelkhand areas, and Vidarbha areas of South India. Even the residues are not available for animals in these areas. In the initial evaluation trials at the farm of Gurukul Kurukshetra, use of plastic mulch with drip irrigation and application of Jeevamrit through drip irrigation has given very encouraging results. These results are showing that by the use of this technique there is a possibility of taking multi-crops for multi-seasons without ploughing the field and without incurring cost on the control of weeds.

5. **Residue management**: Preference should be given for retaining crop residues on the soil surface instead of their incorporation in the soil. No burning of crop residues.

6. **Green manuring** of Sesbania or any other legume crop before planting of the crop as it acts as a source of food for microbes as well as the crop planted.

7. Use of bio-formulations/natural inputs of natural farming as suggested by Shri Subhash Palekar.

8. **Wapsaa**: Wapsaa approximately emulates the condition of field capacity in which soil macropores are filled with air and micropores with moisture. Drip/sprinkler irrigation maintains wapsaa condition in more better way. Flood irrigation should be avoided.

9. **Drip/sprinkler irrigation** with the conjunctive use of Jeevamrit as given in Point No. 3.

10. **Biodiversity**: Combination of different crops (intercrops) grown simultaneously. Multilayer farming is the best model of biodiversity particularly under problematic, nutrient deficient soils and rainfed conditions.

Annexure- XVI

Natural Farming Pest management file prepared by NF cell, INM Division, DoA&FW and validated by ICAR - IIFSR, NIPHM, TNAU, UAS Dharwad, PJTSAU Hyderabad, SDAU Gujarat, Dr BSKKV Dapoli Maharashtra, CSKHPKV Palampur Himachal Pradesh and IGKV Chhattisgarh

Maize crop - Insect Pest Management in Natural Farming								
Background - Maize is a significant Kharif and Rabi crop in India, grown for food, fodder, and industrial use. Fall armyworm and stem borers are major pests, causing substantial yield losses. The pests mentioned are having national and regional importance. The assumption here is that the resources are readily available and easy to practice								
Suggested multi-crops		**Inter Crops**	Pulses (Green gram, Black gram, Cow pea etc.,) Sunflower, Tuber vegetables (Carrot, Radish), Vegetable and Creeper vegetables					
		Trap crops & Attractants	Sunflower, Okra, Coriander, Chrysanthemum, Marigold and Mustard.					
		Border crops	4 rows of Jowar or Bajra or Napier grass before sowing the main crop					
S No	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**

1	Maize stem borer	*Chilo partellus*	Vegetative to Reproductive stage	**Egg** - Flat, Oval and creamy eggs (20-150 cluster) on both sides of leaves **Larva**- Yellowish brown larva with brown head **Pupa** - Brownish **Adult** - Straw/ creamy colour moths	1. Trap crops 2. Encourage or inundate release of predators or parasitoids 3. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 200 liter/acre (Melia azadirach can be used if neem is not available)	1. Encourage or inundate release of predators or parasitoids 2. Intercrop with cowpea/Black gram/Green gram in 2:1 ratio 3. Install Bird perches upto plant attaining 1 meter height	1. Cleaning the field after the crop harvesting	1. Install one light traps(preferable solar light trap inside the field) & 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution @200 liter/acre (Melia azadirach can be used if neem is not available)
2	Pink stem borer	*Sesamia inferens*	Vegetative to Reproductive stage	**Egg**: Creamy white spherical eggs laid in batches in between leaf sheaths and stem of the plant. **Larva**: Pinkish brown with a reddish brown head. **Pupa**: Brown, obtect pupa, pupates inside the stem.	1. Trap crops 2. Encourage or inundate release of predators or parasitoids 3. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (	1. Encourage or inundate release of predators or parasitoids 2. Intercrop with cowpea/Black gram/Green gram in 2:1 ratio 3. Install Bird perches upto plant attaining 1	1. Cleaning the field after the crop harvesting	1. Install one light traps(preferable solar light trap inside the field) & 10 pheromone traps per acre

				Adult: Straw coloured moth with forewings having 3 black spots and a faint brown mid-stripe with white hindwings.	Melia azadirach can be used if neem is not available)	meter height		
3	Shoot fly	*Atherigona spp.*	All stages	**Egg** - Cigarette shape, white coloured laid generally singly parallel to the midrib on the under surface of the 3rd to 5th leaf **Larva** - Creamy white to Yellow caterpillar **Pupa** - Brownish **Adult** - Small grey coloured fly (Resembles house fly)	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1. 5% NSKE/Neem leaf extract with soap solution (Melia azadirach can be used if neem is not available) 2. Fish meal traps @4 / acre	1. Cleaning the field after the crop harvesting	1. 5% NSKE/Neem leaf extract with soap solution 2. Spraying of Chilli garlic based solution
4	White grub	*Holotrichia consanguinea*	All stages	**Egg** - Cluster of white eggs **Larva** - White to creamy colour, C-Shaped **Pupa** - Yellow to darker brown **Adult** - Shiny reddish brown	1. Summer ploughing 2. Use only well decomposed organic manures	1. Neem cake - 200kg/acre (Melia azadirach can be used if neem is not available) 2. Hand picking and destroying the grubs	1. Cleaning the field after the crop harvesting	1. Install light traps 2. Soil application of Metarrhizum @5kg/ha 3. Hand picking and destroy the insects

5	Cut Worm	*Agrotis ipsilon*	Vegetative stage	**Egg** - White to Darker **Larva**- Light yellowish green caterpillar **Pupa** - Brownish **Adult** - Brown coloured moth with white hind wings	1. Trap crops 2. Encourage or inundate release of predators or parasitoids 3. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1. Spray Neem leaf extract early stages 2. Spray Chilli garlic extract at later stages of pest	1. Cleaning the field after the crop harvesting	1. Install one light traps(preferable solar light trap inside the field) & 10 pheromone traps per acre

6	Fall army worm	*Spodoptera frugiperda*	Vegetative to Reproductive stage	**Egg** - White to darker mass dome shaped, base is flattened and the egg curves upward to a broadly rounded point at the apex. Mass of 100 to 200 and eggs are spread over a single layer attached to foliage. The female also deposits a layer of grayish scales between the eggs and over the egg mass, imparting a furry or moldy appearance. **Larva** - Shades of Green, olive, tan and grey with 4 black spots in each abdominal segment and has three creamy yellow lines running down its back. **Pupa**- Reddish brown **Adult** - Male moth has a white patch at the apical margin of	1. Trap crops 2. Hand picking and destroying eggs/egg mass 3. Egg eating insects 4. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1. Encourage or inundate release of predators or parasitoids 2. Application of a mix of Neemastra + Agniastra at Vegetative stage (Melia azadirach can be used if neem is not available) 3. Application of Neemastra + Brahmastra and Dashparni @3% in sequence at the whorl of maize plant (Melia azadirach can be used if neem is not available) 2. Intercrop with cowpea/Black gram/Green gram in 2:1 ratio	1. Cleaning the field after the crop harvesting	1. Install one light traps(preferable solar light trap inside the field) & 10 pheromone traps per acre

				forewing. Forewing of female is dull with faint markings.				
7	Aphid	*Rhopalosiphum maidis*	Vegetative to Reproductive stage	**Egg** - Yellow, elliptical shaped, Glued to stem or leaves **Nymph** - Yellow with dark green legs **Adult** - Small black fly	Conservation of natural enemies such Lady Bird Beetles, chrysoperla and syrphidae	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection	1. Cleaning the field after the crop harvesting	Spraying of Vitex leaf decoction

Redgram crop - Insect Pest Management in Natural Farming		
Background - Red Gram is an important pulse crop in rainfed areas, providing protein to rural diets. Pod borers and pod fly are common pests. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice		
Suggested multi-crops	**Inter Crops**	Jowar, Bajra, Maize, Castor, Cluster beans, Cowpea, French bean, Ground nut, Tuber vegetables (Carrot and Radish) and creeper vegetables (Cucumber, Bottle gourd and Ridge gourd), Vegetables (Chilli, lablab, Okra, Tomato)
	Trap crops & Attractants	Cowpea, Castor and Marigold

		Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**
1	Pod borer	*Helicoverpa armigera*	Flowering stage to Harvesting	**Eggs** – Spherical in shape and creamy white in colour, laid singly **Larva** - Shows colour variation from greenish to brown. Green with dark brown grey lines laterally on the body with lateral white lines and also has dark and pale bands. **Pupa** – Brown in colour, occurs in soil, leaf, pod and crop debris **Adult** - Light pale brownish yellow stout moth. Fore wing grey to pale brown with V shaped speck.Hind wings are pale smoky white with a broad blackish outer margin.	1. Trap crops 2. Encourage or inundate release of predators or parasitoids 3. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Install one light traps(preferable solar light trap inside the field) 2. Installation of Bird perches @ 20/acre.	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2. Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)

2	Pod fly	*Melanagromyza obtusa*	Flowering stage to Harvesting	**Eggs**: Eggs are laid by them singly or in cluster inside the pod wall by piercing through the ovipositor. The fly lays about 60-80 white eggs. **Larva** - Greenish having brown lateral marking and humped anal segment **Pupa** - Red to darker colour **Adult** - Moths are yellowish brown in colour and Forewings - yellow coloured with 'V' shaped specks	1. Trap crops 2. Encourage or inundate release of predators or parasitoids 3. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Encourage or inundate release of predators or parasitoids 2. Placing Bird perches @8/acre during early stages of crop 3. Spraying of Chilli garlic based solution- 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2. Planting trap crops on the bunds/borders 3. Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
3	Leaf webber	*Grapholita critica*	Vegetative stage	**Eggs** - Freshlylaid eggs were flattened, oval, transparent, dull white and round at both ends **Larva** - Green with a black head and long white hairs on the body **Pupa** - Pale yellow,which later on changed to reddish brown **Adult** - Forewings – yellow colour with purple patches Hind wings -white	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Encourage or inundate release of predators or parasitoids 2. Placing Bird perches @8/acre during early stages of crop 3. Spraying of Chilli garlic extract - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2. Planting trap crops on the bunds/borders 3. Spraying of Neem leaf solution

4	Spotted pod borer	*Maruca vitrata*	Flowering stage	**Eggs** - Pale cream, translucent (that is, they allow light through), and laid singly on the stems, young leaves, flowers and pods. **Larva** - pale cream, with two rows of dark dots on their backs **Pupa** - Brown to black in colour, Silk webbed inside the soil or damaged pods **Adult** - The moths have brown front wings, with white patches. The hind wings are mostly white with a brown border. They can be found under the lower leaves of the host plants.	1. Trap crops 2. Encourage or inundate release of predators or parasitoids 3. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Encourage or inundate release of predators or parasitoids 2. Placing Bird perches @8/acre during early stages of crop 3. Spraying of Chilli garlic based solution - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2. Planting trap crops on the bunds/borders 3. Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)

5	Plume moth	*Exelastis atom*	Vegetative stage	**Egg** - Some plume moths produce eggs that have distinct reticulations. In general, the eggs are oval or elliptical, glossy, white or pale yellow and about 0.4 mm long. **Larva** - Larvae of plume moths can be recognized by their slender, stalk-like prolegs and their setae with swollen tips. Full-grown larvae are about 10 mm long and tapered at both ends. **Pupa** - Usually the pupae are not in cocoons. They vary from very light to brown, are angulate, and are about 10 mm long. **Adult** - Plume moths have slender bodies and legs. They are white or brownish with a wingspan from 15 to 25 mm. The members of this genus are very closely related, and it is often difficult to determine which species is involved by adult specimens.	1. Trap crops 2. 5% NSKE / Neem leaf extract	1. Installation of Bird perches @ 20/acre. 2. Spraying of 200 lit Neem leaf extract at early stages (Melia azadirach can be used if neem is not available) 3. Spraying of 5 Leaf extract spray at later stages (@ 6 lit/100 lit water per acre)	1. Cleaning the field after the crop harvesting	Install one light traps(preferable solar light trap inside the field) & 10 pheromone traps per acre

6	Pulse beetle	*Callosobruchus chinensis*	Vegetative to Flowering stage	**Egg** - The eggs occur singly and have a yellow coloring which become opaque when hatched **Larva** - yellowish-white with a brown head and reduced legs, about 5 mm long. **Adult** - The elytra are red-brown with yellow makings, antennae and legs yellow, female antennae serrate, those of male pectinate.	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Hand picking or shaking the plants 2. Spraying of Chilli garlic extract	Control weed growth on bunds	1 light trap / acre Installation of Bird perches @ 20/acre.
7	Blister beetle	*Mylabris phalerata*	Flowering stage	**Eggs** - are light yellowish in colour and cylindrical in shape. **Larva** - Young grubs are white in colour. **Adult** – Elytra are black in colour with a round orange spot and two transverse wavy orange bands across the wings.	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Hand picking or shaking the plants 2. Spraying of Chilli garlic extract	1. Cleaning the field after the crop harvesting	Manual collection or collection with insect net and killing of adults in kerosenized water is the only possible solution.

Groundnut crop - Insect Pest Management in Natural Farming		
Background - Groundnut is a major oilseed crop in Kharif, widely cultivated in semi-arid regions. Pests like leaf miners, thrips, and aphids affect productivity. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice		
Suggested multi-crops	**Inter Crops**	Red gram/Cowpea/Maize/Sunflower in 5:1 or 7:1 ratio

		Trap crops & Attractants	Marigold and Castor, Carrot, Mustard etc					
		Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**
1	Red hairy caterpillar	*Amsecta albistriga*	Vegetative growth (After 10 days of sowing)	**Eggs –** Cream coloured, about 600-700 eggs under surface of the leaves **Larva** - Reddish brown with black bands on both ends and long reddish brown hairs all over the body **Pupa –** Pupa is seen below the soil near bunds **Adult** - Moths have white forewings with brownish streaks all over and a yellowish streak along the anterior margin and head. Hind wings are white with black markings.	1. Trap crops 2. Encourage or Inundate release of Predators or Parasitoids 4. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Encourage or Inundate release of Predators or Parasitoids	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Chilli garlic solution

2	White grub	*Lachnosterna serrata*	After 50 days of sowing	**Eggs -** 20 - 80 white, roundish eggs in clusters **Larva** - Young grubs are translucent, whitish yellow in colour , fleshy 'C' – shaped **Pupa** - Pupates in soil and remain as pupae until the following year **Adult -** Dark brown beetle. Beetles emerge out of the soil within 3-4 days after the onset of rain.		1. Encourage or Inundate release of Predators or Parasitoids	1. Cleaning the field after the crop harvesting	Application of Neem cake @ 200 kg/acre (Melia azadirach can be used if neem is not available)
3	Thrips	*Scirtothrips dorsalis*	10 days to 45 days after sowing	**Eggs** – 40-50 eggs inside the tissues of leaves and shoot. **Nymph** – Yellowish **Adult** - Dark coloured with fringed wings	Grow Marigold as Trap crop	1. Blue sticky traps @4-5 /acre 2.5% NSKE/Neem leaf extract with soap solution (Melia azadirach can be used if neem is not available)	Pupation takes place in the leaf folders. Collect them and destroy	Spraying of 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available)
4	Leaf Minor	*Aproarema modicella*	20 to 50 days after sowing	**Eggs** – Shiny white and are laid singly on the underside of the leaflets **Larva** - Green in colour with dark head and prothroax **Adult** - Brownish grey moth, 6 mm long with 10 mm wing span. Forewings with white	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids like Lace wing, Lasdy bird beetle 2. Spraying of Chilli garlic based	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf

				spot on the costal margin		solution- 6 litres in 200 litres of water		solution (Melia azadirach can be used if neem is not available)
5	Aphids	*Aphis craccivora*	20 to 50 days after sowing	**Nymph & Adult** - Reddish to dark brown coloured with cornicles in the abdomen	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection	1. Cleaning the field after the crop harvesting	Spraying of Vitex leaf decoction
6	Jassid	*Empoasca kerri*	Through out the crop period	**Eggs** – Elongated yellow-white egg is deposited in leaf vein. **Nymph -** Pale-green, wedge shaped, winged pads extend up to the fifth abdominal segment **Adult** - It is a wedge shaped and pale green insect	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract during initial stage	1. Cleaning the field after the crop harvesting	Spraying Neem leaf extract (Melia azadirach can be used if neem is not available)

7	Tobacco caterpillar	*Spodoptera litura*	after 45 days of sowing to harvesting	**Eggs** – Masses appear golden brown **Larva** - Pale greenish with dark markings **Adult** - Forewings are brown in colour with wavy white marking, hind wings are white in colour with a brown patch along the margin	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1.Erect bird perches @8 per acre 2.5%NSKE/Neem leaf extract during intial stage @ twice a week (Melia azadirach can be used if neem is not available) 3.Spray Chilli garlic based solution if pest is severe	1. Cleaning the field after the crop harvesting	Install 1 light traps & 10 pheromone traps per acre

Rice crop - Insect Pest Management in Natural Farming		
Background - Rice is the staple food of India, grown in Kharif and Rabi seasons in diverse agro-climatic zones. Pests like stem borers, brown plant hoppers, and leaf folders are widespread. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice		
Suggested multi-crops	**Inter Crops**	Pre monsoon green manure crop sowing with Sesbania, Sunhemp etc
	Trap crops & Attractants	Mari gold, Redgram, Carrot and Raddish, Sesame or Okra on Bunds
	Border crops	Redgram, Sesbania, Glyricidia

Sno	Pest name	Scientific name	Incidence at crop stage	Identification of the pest	Pest management in Egg stage	Pest management in larval stage/ Nymph stage	Pest management in Pupal stage	Pest management in Adult stage
1	Yellow stem borer	*Scirpophaga incertulas*	Nursery to Panicle stage	**Eggs** – Eggs are creamy white, flattened, oval and laid in a mass which is covered with buff coloured hairs. They are laid mostly near the tip of the leaves. **Larva** - Pale yellow with dark brown head having prothoracic shield. Larval period is 28 to 30 days. **Pupa** – White silken cocoon. Pupation takes place inside the rice stem, straw or stubble. Pupal period is 8 to 10 days **Adult** - **Female moth** : Has bright yellowish brown with a black spot at the centre of the fore wings and a tuft of yellow hairs at the anal region. **Male moth :** Smaller with pale yellow forewings without black spot.	1. Hand picking and destroying eggs/egg mass or clipping of leaf tips 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Chilli garlic based solution	1. Cleaning the field after the crop harvesting 2. Growing green manuring crop and incorporating in soil	1. Install 10 pheromone traps per acre 2.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)

2	Leaf folder	*Cnaphalocrocis medinalis*	Early vegetative stage to Panicle stage	**Eggs –** Flat, oval in shape and yellowish white in colour. **Larva** - Greenish translucent, prothoracic shield straight apically and rounded laterally. **Pupa –** Pupal period is 7 to 10 days. **Adult** - Moth is yellow brownish wings with many dark wavy lines in centre and dark band on margin of wings.	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids like Spider, Dragon fly 2. Placing Bird perches @8/acre 3. Spraying of Chilli garlic based solution	1. Cleaning the field after the crop harvesting	1. Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
3	Brown plant hopper	*Nilaparvata lugens*	Early tillering stage to Panicle stage	**Eggs –** White, transparent, slender cylindrical and curved eggs are thrust in straight-line in two rows. (They are covered with a dome - shaped egg plug secreted by the female **Nymph -** Freshly hatched nymph is cottony white, 0.6 mm long and it turns purple-brown, 3.0 mm long in the fifth instar. **Adult** - Adult hopper is 4.5-5.0 mm long and has a yellowish brown to dark brown body. The wings are sub hyaline with a dull yellowish tint. It has two characteristic wing morphs: macropterous (long winged)	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids like Spider, Dragon fly 2. Alley path ways in the field 3. White and yellow sticky traps @25 /acre 4. 1 light trap per acre	-	1. White and yellow sticky traps @25 /acre 2. 1 light trap per acre

				and brachypterous (short winged).				
4	Gall midge	*Orseolia oryzae*	Early tillering stage	**Eggs** – Reddish, elongate, tubular eggs just near the ligule of the leaf blade **Larva** - Maggot is pale to red colour feeds inside the gall. **Pupa** – Pupates at the base of the gall and moves to tip of the gall. **Adult** - Adult is orange coloured mosquito like fly	1. Trap crops/ light traps 2. Egg eating insects 3. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Spraying of Chilli garlic based solution - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	
5	Rice hispa	*Dicladispa armigera*	Early tillering stage	**Eggs** – Eggs are laid inside minute slits on the tender leaves generally toward the tip. **Grub** - The grub is whitish yellow and flattened. It feed inside the leaf tissue by mining. It pupates inside. **Adult** - The adult beetle is somewhat square shaped about 1/6 to 1/8” in length and width Dark blue or blackish in colour with spines all over the body.	1. Clipping of leaf tips 2. Egg eating insects 3. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Installation of Bird perches @ 20/acre. 2. Spraying of 200 lit Neem leaf extract at early stages (Melia azadirach can be used if neem is not available) 3. Spraying of 5 Leaf extract spray at later stages (@ 6 lit/100 lit water per acre)	1. Cleaning the field after the crop harvesting	1 light trap / acre Installation of Bird perches @ 20/acre.

6	Mite	*Steneotarsonemus spinki*	Panicle to Grain filling stage	The mite is not visible to naked eyes		1. Spraying of Cow urine+Dung+ Asfoetida solution		1. Destroy the infected parts 2. Spraying of Cow urine+Dung+ Asfoetida solution
7	Green leaf hopper	*Nephotettix cincticeps*	Early tillering stage to Panicle stage	**Eggs –** Greenish transparent eggs are deposited in the midrib of leaf blade or sheath of rice or green grass. They are laid in batches of 10 to 15 arranged in a single row. **Nymph -** The nymphs are soft bodied, yellow white in colour. Gradually the colour changes to green with five nymphal instars and become adults in 18-20 days. **Adult** - Adults are 3-5 mm long, bright green with variable black markings, wedge shaped with a characteristic diagonal movement.	1. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. 1 Light trap per acre 2. Yellow sticky traps @ 20 -25/acre 3. Spraying of Nirgundi leaf extract	-	Spraying of Nirgundi leaf extract

8	Gundhi bug	*Leptocorisa acuta*	Flowering to Grain filling stage	**Eggs –** Eggs are circular, brownish seed like, 2 mm long, laid in clusters in two rows along the midrid on the upper surface of the leaf-blade. **Nymph -** First instar is small, 2 mm long, pale green in colour, which grows to deep green through different instars. **Adult** - Adults are greenish yellow, long and slender, above ½ inch in length with a characteristic buggy odour.	1. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Hand picking or shaking the plants 2. Spraying of Chilli garlic extract	-	Manual collection or collection with insect net and killing of adults in kerosenized water is the only possible solution.

Chickpea crop - Insect Pest Management in Natural Farming								
Background - Chickpea is a vital Rabi pulse crop, mainly grown in India. Pod borers and cutworms are significant threats. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice								
Suggested multi-crops		**Inter Crops**	Inter crops with Coriander or Mustard					
		Trap crops & Attractants	Marigold, Okra, Carrot and Raddish					
		Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop					
Sno	**Pest name**	**Scientific name**	**Incidence at crop**	**Identification of the pest**	**Pest management in**	**Pest management in larval stage/**	**Pest management in**	**Pest management in**

			stage		Egg stage	Nymph stage	Pupal stage	Adult stage
1	Gram pod borer	*Helicoverpa armigera*	Vegetative to Reproductive stage	**Eggs** – Spherical in shape and creamy white in colour, laid singly **Larva** - Shows colour variation from greenish to brown. Green with dark brown grey lines laterally on the body with lateral white lines and also has dark and pale bands. **Pupa** – Brown in colour, occurs in soil, leaf, pod and crop debris **Adult** - Light pale brownish yellow stout moth. Fore wing grey to pale brown with V shaped speck.Hind wings are pale smoky white with a broad blackish outer margin.	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
2	Gram cut worm	*Agrotis ipsilon*	Seedling stage	**Eggs** – Laid on earth clods, chickpea stem bases and on both sides of leaves. **Larva** - Dark brown with red head. **Pupa** – Pupation takes place in earthen cocoon. **Adult** - Moth are brownish with numerous wavy lines and spots, measuring 3 to 5 cm	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not	1. Increase the activity of Predators, parasitoids like Spider, Dragon fly 2. Placing Bird perches @8/acre 3. Spraying of Chilli garlic extract	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can

				across wings	available)			be used if neem is not available)
3	Semi looper	*Autographa nigrisigna*	Vegetative stage	**Larva** - The larva 25 mm long is green semiloopers. **Adult** - Moths have typically patterned forewings.	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids like Spider, Dragon fly 2. Placing Bird perches @8/acre 3. Spraying of Chilli garlic extract - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
4	Grub	*Phyllophaga implicita*	Seedling stage	**Eggs** – small pearl-like eggs in the soil **Larva** - Beetles vary from 12 to 25 mm (0.5 to 1 inch) and have shiny wing covers (elytra) **Pupa** – in the soil		Increase the activity of Predators, parasitoids like Spider, Dragon fly	1. Cleaning the field after the crop harvesting	Application of Neem cake @ 200 kg/acre (Melia azadirach can be used if neem is not available)

Wheat crop - Insect Pest Management in Natural Farming		
Background - Wheat is a primary Rabi crop in North India, essential for food security. Aphids, termites, and armyworms are major pests affecting yields. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice		
Suggested multi-crops	**Inter Crops**	Sunflower, French bean, Inter crop with Cowpea, Onion, Black gram

		Trap crops & Attractants	Mustard, Carrot and Raddish, Chrysanthemum and Marigold					
		Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**
1	Termite	*Odontotermis obesus*	Pre germination	**Eggs** – Dull, kidney shaped and hatches in 30-90 days. **Nymph-** Moult 8-9 times and are full grown in 6-12 months. **Adult** - Creamy coloured tiny insects resembling ants with dark coloured head.	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Seed treatment 2. Application of Neem cake (Melia azadirach can be used if neem is not available)		1. Destroying the Termitarium(Mounds) 2. Application of Neem cake before sowing (Melia azadirach can be used if neem is not available)

2	Wheat aphid	*Sitobian avenae*	Vegetative stage	**Eggs** – Eggs are dirty white in colour and laid along the veins of leaves. **Nymph**- There are four nymphal stages (instars). The general appearance of each stage is similar except for increase in size during subsequent instars. **Adult** - Aphids are small, soft-bodied, pearl-shaped insects that have a pair of cornicles (wax-secreting tubes) projecting out from the fifth or sixth abdominal segment. Aphids are green colour.	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection	1. Cleaning the field after the crop harvesting	Spraying of Vitex leaf decoction

3	Army worm	*Mythimna separata*	Vegetative stage	**Eggs** – Eggs are laid in cluster, consisting of approximately 500 eggs **Larva** - The younge caterpillars hatch from the eggs in 4-5 days. After hatching the caterpillars starts feeding on the leaves of the seedlings. The caterpillars are fully grown in about 15 days and measures 3-5 cm in length. **Pupa** – Pupae are yellowish-brown, shiny. **Adult** - Adult is brownish white in colour. Forewings are grayish-yellow, with dark-gray or reddish-yellow tint. Round and reniform spots are light or yellowish with indistinct edges; reniform spot with white point at lower margin. External wing margin blackened obliquely from top backward, with dark stroke and with a row of dark points. Hind wings are gray, with dark external margin. Antennae are thread-like.	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Intercrop with cowpea in 2:1 ratio 4. Spraying of Agnastra - 3 litres in 100 litres of water/acre	1. Cleaning the field after the crop harvesting	1. Install 1 light traps & 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution @100 liter/acre (Melia azadirach can be used if neem is not available)

4	American pod borer	*Helicoverpa armigera*	Vegetative stage to Ear head stage	**Eggs** – Spherical in shape and creamy white in colour, laid singly **Larva** - shows colour variation from greenish to brown. Green with dark brown grey lines laterally on the body with lateral white lines and also has dark and pale bands. **Pupa** – brown in colour, occurs in soil, leaf, pod and crop debris **Adult** - light pale brownish yellow stout moth. Fore wing grey to pale brown with V shaped speck.Hind wings are pale smoky white with a broad blackish outer margin.	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 1 light traps & 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution @100 liter/acre (Melia azadirach can be used if neem is not available)
5	Brown mite	*Petrobia latens*	Vegetative stage	**Eggs** – Hyaline, globular laid in mass. Eggs are generally laid beneath clods and are either active i.e. red in colour and not visible to the naked eye or dormant i.e. white eggs. **Nymph -** Yellowish in colour **Adult** - The mites are very small measuring about 0.5 mm in length, metallic brown to black with pale yellow legs and	1. Trap crops	1. Destroy the infected parts 2. Spraying of Cow urine+Dung+ Asfoetida solution		1. Destroy the infected parts 2. Spraying of Cow urine+Dung+ Asfoetida solution

				their forelegs are distinctively longer than the other three pair of legs.				
6	Pink stem borer	*Sesamia inferens*	Vegetative stage	**Eggs** – Round pearl like yellowish eggs ranging 80-300 are layed in 2-3 longitudinal rows usually within the sheaths of bottom leaves of young plant of two to three weeks old. As the time for hatching approaches, eggs become brown or shy grey. **Larva** - Newly hatched larvae remain in group behind the leaf sheath and begin chewing on the stem and epidermal layer of the sheath. Full grown larvae are stout smooth about 25 to 30 mm in length purplish pink on the dorsal side and white on ventral side. **Pupa** – Pupa is dark brown in colour. **Adult** - The adult moth is straw-coloured with white wings. Life cycle is completed in 6-7 weeks with 4-5 generations in a year.	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Chilli garlic based solution	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution

7	Shoot fly	*Atherigona naqvii*	Vegetative stage	**Eggs** – The eggs hatch in 1 - 3 days and the maggots which are yellow in colour migrate to the dorsal surface of the leaf, enter the space between the leaf sheath and the axis and make a clean cut at the base of the leaf. The growing point of the plant dies and decays on which the maggots feed. **Larva** - The larval period lasts for 6 - 10 days. **Pupa** – Pupation takes place inside the stem itself and the adults emerge in about a week. **Adult** - The adult is a small dark fly. It deposits whitish eggs singly on the central surface of the leaves. Each female fly is capable of laying 30 eggs during its life time. Life cycle occupies 17 - 20 days.	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre	1. 5% NSKE/Neem leaf extract with soap solution (Melia azadirach can be used if neem is not available) 2. Fish meal traps @4 / acre	1. Cleaning the field after the crop harvesting	1. 5% NSKE/Neem leaf extract with soap solution (Melia azadirach can be used if neem is not available) 2. Spraying of Chilli garlic based solution

Tomato crop - Insect Pest Management in Natural Farming		
Background -Tomato is a commercially important vegetable crop cultivated year-round. Fruit borers, whiteflies, and thrips are common pests. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice		
Suggested	**Inter**	Onion, Tuber vegetables- Carrot, Radish, Flower crops - Marigold, Leafy vegetables and Creeper vegetables – Ridge

multi-crops		Crops	Gourd, Bottle Gourd. Tomato + Black gram/Cowpea (4:1)					
		Trap crops & Attractants	Marigold, Castor, Mustard, Sunflower, Carrot					
		Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**
1	Fruit borer	*Helicoverpa armigera*	Reproductive stage	**Eggs** – Spherical in shape and creamy white in colour, laid singly **Larva** - Shows colour variation from greenish to brown. Green with dark brown grey lines laterally on the body with lateral white lines and also has dark and pale bands. **Pupa** – Brown in colour, occurs in soil, leaf, pod and crop debris **Adult** - Light pale brownish yellow stout moth. Fore wing grey to pale brown with V shaped speck.Hind wings are pale smoky white with a broad blackish outer margin.	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)

2	Tobacco caterpillar	*Spodoptera litura*	All stages	**Eggs** – Masses appear golden brown **Larva** - Pale greenish with dark markings **Adult** - Forewings are brown in colour with wavy white marking, hind wings are white in colour with a brown patch along the margin	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1.Erect bird perches @8 per acre 2.5%NSKE/Neem leaf extract during intial stage @ twice a week (Melia azadirach can be used if neem is not available) 3.Spray Chilli garlic based solution if pest is severe	1. Cleaning the field after the crop harvesting	Install 1 light traps & 10 pheromone traps per acre
3	Leaf minor	*Liriomyza trifolii*	All stages	**Larva** - Minute orange yellowish apodous maggots **Pupa** – Yellowish brown pupates within mines **Adult** - Pale yellow in colour	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids like Spider, Dragon fly 2. Placing Bird perches @8/acre 3. Spraying of Chilli garlic extract - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)

4	Whitefly	*Bemisia tabaci*	Vegetative stage	**Eggs –** Are pear-shaped (approximately 0.2 mm long), with a gleaming white color that darkens over time **Nymph**- Whitish-yellow nymphs turn yellowish and dome-shaped after feeding. The pale yellow freshly molted third instar nymphs, however, gradually turn dark yellow and more flattened in shape after feeding **Adult** - Yellow-bodied with a pair of white wings that form an inverted V-shape covering the thorax and abdomen	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection	1. Cleaning the field after the crop harvesting	Spraying of Vitex leaf decoction
5	Thrips	*Thrips tabaci*	Vegetative stage	**Nymph**- Yellowish **Adult** - Dark coloured with fringed wings	Grow Marigold as Trap crop	1. Blue sticky traps @4-5 /acre 2.5% NSKE/Neem leaf extract with soap solution (Melia azadirach can be used if neem is not available)	Pupation takes place in the leaf folders. Collect them and destroy	Spraying of 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available)

6	Spider mite	*Tetranychus spp.*	Vegetative stage	**Eggs** – Hyaline, globular laid in mass **Nymphs** - Yellowish in colour **Adult** - Red coloured small sized	1. Trap crops	1. Destroy the infected parts 2. Spraying of Cow urine+Dung+ Asfoetida solution		1. Destroy the infected parts 2. Spraying of Cow urine+Dung+ Asfoetida solution
7	Aphids	*Aphis gossypii, Aphis craccivora*	All stages	**Nymph & Adult** - Reddish to dark brown coloured with cornicles in the abdomen	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection	1. Cleaning the field after the crop harvesting	Spraying of Vitex leaf decoction

Okra crop - Insect Pest Management in Natural Farming		
Background - Okra (Bhendi) is a widely grown vegetable in India during Kharif and summer seasons. Fruit borers, whiteflies, and aphids often damage the crop. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice		
Suggested multi-crops	**Inter Crops**	Coriander (2:1), Bhendi + Leafy vegetables + Creepers, Bhendi + Cowpea (2: 1) and Bhendi + Onion/ Garlic (within the row, between two Bhendi plants), Bhendi + Leafy Vegetables (Coriander)+ Onion/Garlic (in between two Bhendi plants one Onion plant.

		Trap crops & Attractants	Mari gold and Castor Carrot and Raddish					
		Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**
1	Fruit and Shoot borer	*Earias vitella, E. insulana*	Vegetative stage to Fruiting stage	**Eggs** – Sculptured egg and sky blue in colour **Larva** - Brownish with white streaks dorsally and pale yellow ventrally **Pupa** – Brown and boat shaped **Adult** - Forewing are pale with a wedge shaped green band in the middle	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution

2	Fruit borer	*Helicoverpa armigera*	Fruiting stage	**Eggs** – Spherical in shape and creamy white in colour, laid singly **Larva** - Shows colour variation from greenish to brown. Green with dark brown grey lines laterally on the body with lateral white lines and also has dark and pale bands. **Pupa** – Brown in colour, occurs in soil, leaf, pod and crop debris **Adult** - Light pale brownish yellow stout moth. Fore wing grey to pale brown with V shaped speck.Hind wings are pale smoky white with a broad blackish outer margin.	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of 10 leaf extract solution	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
3	White fly	*Bemisia tabaci*	Vegetative stage to Fruiting stage	**Eggs** – Are pear-shaped (approximately 0.2 mm long), with a gleaming white color that darkens over time **Nymph**- Whitish-yellow nymphs turn yellowish and dome-shaped after feeding. The pale yellow freshly molted third instar nymphs, however, gradually turn dark yellow and more flattened in shape after	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at		Spraying of Vitex leaf decoction

				feeding **Adult** - Yellow-bodied with a pair of white wings that form an inverted V-shape covering the thorax and abdomen		severe infection		
4	Aphids	*Aphis gossypii*	Vegetative stage	**Nymph & Adult** - Reddish to dark brown coloured with cornicles in the abdomen	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection	1. Cleaning the field after the crop harvesting	Spraying of Vitex leaf decoction
5	Red Spider mite	*Tetranychus spp.*	Vegetative stage	**Eggs** – Hyaline, globular laid in mass **Nymphs** - Yellowish in colour **Adult** - Red coloured small sized	1. Trap crops	1. Destroy the infected parts 2. Spraying of Cow urine+Dung+ Asfoetida solution		1. Destroy the infected parts 2. Spraying of Cow urine+Dung+ Asfoetida solution

6	Red cotton bug	*Dysdercus cingulatus*	Vegetative stage	**Nymphs and Adults -** Reddish bugs with white bands on the abdomen and black markings on the wings		1. Hand picking or shaking the plants 2. Spraying of Neem leaf extract (Melia azadirach can be used if neem is not available)		Spraying of Neem leaf extract (Melia azadirach can be used if neem is not available)
7	Jassids	*Amrasca biguttula*	Vegetative stage	**Eggs** – Greenish transparent eggs are deposited in the midrib of leaf blade or sheath of rice or green grass. They are laid in batches of 10 to 15 arranged in a single row. **Nymph -** The nymphs are soft bodied, yellow white in colour. Gradually the colour changes to green with five nymphal instars and become adults in 18-20 days. **Adult** - Adults are 3-5 mm long, bright green with variable black markings, wedge shaped with a characteristic diagonal movement.	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. 1 Light trap per acre 2. Yellow sticky traps @ 20 -25/acre 3. Spraying of Nirgundi/ neem leaf extract (Melia azadirach can be used if neem is not available)		Spraying of Nirgundi leaf extract

Chilli crop - Insect Pest Management in Natural Farming
Background - Chilli is an economically valuable spice crop grown year-round in India. Thrips, mites, and fruit borers often affect yields. The pests

mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice								
Suggested multi-crops		**Inter Crops**	Tubers and other vegetables (Onion, Radish, and Leafy vegetables including Coriander etc.,)					
		Trap crops & Attractants	Mari gold and Castor					
		Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**
1	Chilli thrips	*Scirtothrips dorsalis*	All stages (Transmits Leaf curl disease)	**Nymph -** Are small, linear, easily fragile abdomen with straw yellow colour **Adult** - Dark coloured with fringed wings	Grow Marigold as Trap crop	1. Blue sticky traps @4-5 /acre 2.5% NSKE/Neem leaf extract with soap solution (Melia azadirach can be used if neem is not available)	Pupation takes place in the leaf folders. Collect them and destroy	1.Spraying of 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 2.Spraying of Vitex leaf extract if the disease incidence is more

2	Gram pod borer	*Helicoverpa armigera*	Fruiting stage	**Eggs** – Spherical in shape and creamy white in colour, laid singly **Larva** - Shows colour variation from greenish to brown. Green with dark brown grey lines laterally on the body with lateral white lines and also has dark and pale bands. **Pupa** – Brown in colour, occurs in soil, leaf, pod and crop debris **Adult** - Light pale brownish yellow stout moth. Fore wing grey to pale brown with V shaped speck.Hind wings are pale smoky white with a broad blackish outer margin.	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
3	Tobacco caterpillar	*Spodoptera litura*	All stages	**Eggs** – Masses appear golden brown **Larva** - Pale greenish with dark markings **Adult** - Forewings are brown in colour with wavy white marking, hind wings are white in colour with a brown patch along the margin	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1.Erect bird perches @8 per acre 2.5%NSKE/Neem leaf extract during intial stage @ twice a week (Melia azadirach can be used if neem is not available)	1. Cleaning the field after the crop harvesting	Install 1 light traps & 10 pheromone traps per acre

						3.Spray Chilli garlic based solution if pest is severe		
4	Aphids	*Aphis gossypii, Myzus persicae*	All stages	**Nymph & Adult** - Reddish to dark brown coloured with cornicles in the abdomen	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection	1. Cleaning the field after the crop harvesting	Spraying of Vitex leaf decoction
5	Yellow mite	*Polyphagotarsonemus latus*	All stages	**Eggs** – Oval shaped eggs and white in colour **Nymph -** White in colour **Adult** - Large, oval and broad and yellowish in colour	1. Trap crops	1. Destroy the infected parts 2. Spraying of Cow urine+Dung+ Asfoetida solution		1. Destroy the infected parts 2. Spraying of Cow urine+Dung+ Asfoetida solution
6	Spider mite	*Tetranychus spp.*	Vegetative stage	**Eggs** – Hyaline, globular laid in mass **Nymphs** - Yellowish in colour **Adult** - Red coloured small sized	1. Trap crops	1. Destroy the infected parts 2. Spraying of Cow urine+Dung+ Asfoetida solution		1. Destroy the infected parts 2. Spraying of Cow urine+Dung+ Asfoetida

								solution

Mango crop - Insect Pest Management in Natural Farming								
Background - Mango, the “king of fruits,” is cultivated extensively in tropical and subtropical regions. Fruit flies, hoppers, and mealybugs are common pests. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice								
Suggested multi-crops		**Inter Crops**	Upto 4 years old plant					
			Millets, Vegetables, Pulses, Leafy vegetables and creepers. Fruit plants like Papaya, drumstick					
		Trap crops & Attractants	Sunflower, carrot, raddish, Creepers etc					
		Wind breaks	Sesbania, Glyricidia, Malabar neem, Teak etc					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**
1	Mango stem borer	*Batocera rufomaculata*	All the stages	Grub - Linear, fleshy, apodous Adult - Grayish beetle with two pink dots and lateral spine	1. Egg eating insects 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Application of Neem paste to the stem (Melia azadirach can be	1. Cleaning the field after the crop harvesting	1. Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)

						used if neem is not available) 3. Spraying of Multi leaf solution		
2	Bark borer	*Indarbela tetraonis*	All the stages	**Larva** - Stout and dirty brown in colour **Adult** - Stout yellowish –brown moth with brown wavy markings on the forewings Hind wings is white colour. Males are smaller than the females	1. Egg eating insects 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Application of Neem paste to the stem 3. Spraying of Multi leaf solution	1. Cleaning the field after the crop harvesting	1. Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
3	Shoot borer	*Clumetia transversa*	All the stages	**Larva** - Caterpillar is dark pink with dark brown prothroacic shield. **Adult** - Adult is greyish moth with grey wings having wavy lines.	1. Egg eating insects 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Application of Neem paste to the stem (Melia azadirach can be used if neem is not available) 3. Spraying of Multi leaf solution	1. Cleaning the field after the crop harvesting	1. Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)

4	Mango hoppers	*Idioscopus niveoparsus*	Panicle initiation to fruiting	**Nymph** - Nymphs pale yellow, very active and hide in lower shoots or in cracks in the barks. **Adult** - Dark with wavy lines on wings and three spots on scutellum.	1. Egg eating insects 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids like Lace wing, Lasdy bird beetle 2. Spraying of Soil solution at intial stages 3. Spraying of Chilli garlic based solution		1. Avoid close planting 2. Spraying of Chilli garlic based solution
5	Fruit fly	*Bactrocera (Dacus) dorsalis*	Flowering to fruiting	**Larva** - Yellowish apodous maggots. **Adult** - Light brown with transparent wing	1. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Collection of infected fruits and destroy them 2. Spraying of 5 leaf solution 3. Spraying of Multi leaf solution at later stages	1. Cleaning the field after the crop harvesting	1. Erection of 8 fruitfly trap / acre or Jaggery/mollasses solution with kerosene
6	Mango nut weevil	*Sternochaetus mangiferae*	Flowering to fruiting	**Grub** - A full grown grub is legless, fleshly and yellow with dark head. **Adult** - Adult is dark brown with a short snout.	1. Egg eating insects 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Hand picking or shaking the plants 2. Spraying of Chilli garlic extract	Control weed growth on bunds	4 light trap / acre

7	Gaint mealybug	*Drosicha mangiferae*	December	**Nymph** - Pinkish nymph	1. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Hand picking or shaking the plants 2. Spraying of Chilli garlic extract	1. Cleaning the field after the crop harvesting	Manual collection or collection with insect net and killing of adults in kerosenized water is the only possible solution.

Black gram/ Green gram crop - Insect Pest Management in Natural Farming								
Background - Black gram and Green gram are crucial pulse crops in India, and are grown in Kharif and Rabi seasons. Pod borers and aphids are major threats. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice								
Suggested multi-crops		**Inter Crops**	Maize and Groundnut					
		Trap crops & Attractants	Mustard, Marigold, Cowpea, Cluster Bean, Carrot, French Bean, Sunflower,					
		Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**

1	Spotted pod borer	*Maruca vitrata*		**Eggs-** 400 scaly eggs singly or in clusters of 2 - 16 in the sepals, petals of the flower or buds or on pods. **Larva-**Young ones - dull white Grownup larvae - black-headed, with irregularly shaped brown or black spots on the dorsal, lateral and ventral surfaces of each body segment. **Pupa** - In double-walled pupal cell under the leaf debris or soil **Adult** - Light brown forewings with white markings and white transparent hind wings with brown irregular markings at the lateral edge.	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of 10 leaf extract- 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
2	Pod borer	*Helicoverpa armigera*	Fruiting stage	**Eggs** – Spherical in shape and creamy white in colour, laid singly **Larva** - shows colour variation from greenish to brown. Green with dark brown grey lines laterally on the body with lateral white lines and also has dark and pale bands. **Pupa** – brown in colour, occurs	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can

				in soil, leaf, pod and crop debris **Adult** - light pale brownish yellow stout moth. Fore wing grey to pale brown with V shaped speck.Hind wings are pale smoky white with a broad blackish outer margin.				be used if neem is not available)
3	Leaf hopper	*Empoasca kerri*	Vegetative stage to Fruiting stage	**Eggs** – Greenish transparent eggs are deposited in the midrib of leaf blade or sheath of rice or green grass. They are laid in batches of 10 to 15 arranged in a single row. **Nymph -** The nymphs are soft bodied, yellow white in colour. Gradually the colour changes to green with five nymphal instars and become adults in 18-20 days. **Adult** - Adults are 3-5 mm long, bright green with variable black markings, wedge shaped with a characteristic diagonal movement.	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. 1 Light trap per acre 2. Yello wsticky traps @ 20 -25/acre 3. Spraying of Nirgundi leaf extract	1. Cleaning the field after the crop harvesting	Spraying of Nirgundi leaf extract

4	Whitefly	*Bemisia tabaci*	Vegetative stage to Fruiting stage	**Eggs –** Are pear-shaped (approximately 0.2 mm long), with a gleaming white color that darkens over time **Nymph**- Whitish-yellow nymphs turn yellowish and dome-shaped after feeding. The pale yellow freshly molted third instar nymphs, however, gradually turn dark yellow and more flattened in shape after feeding **Adult** - Yellow-bodied with a pair of white wings that form an inverted V-shape covering the thorax and abdomen	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neemastra with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection		Spraying of Vitex leaf decoction
5	Bean Aphids	*Aphis craccivora*	All stages	**Nymph & Adult** - Reddish to dark brown coloured with cornicles in the abdomen	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neemastra with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection	1. Cleaning the field after the crop harvesting	Spraying of Vitex leaf decoction

6	Blister beetle	*Mylabris phalerata*	Flowering stage	**Eggs** - are light yellowish in colour and cylindrical in shape. **Larva** - Young grubs are white in colour. **Adult** – Elytra are black in colour with a round orange spot and two transverse wavy orange bands across the wings.	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Hand picking or shaking the plants 2. Spraying of Chilli garlic extract	1. Cleaning the field after the crop harvesting	Manual collection or collection with insect net and killing of adults in kerosenized water is the only possible solution.

Cabbage/ Cauliflower crop - Insect Pest Management in Natural Farming								
Background - Cabbage & Cauliflower are major winter vegetables in India. Diamondback moths and aphids are primary pests affecting quality and yield. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice								
Suggested multi-crops		**Inter Crops**	Tuber crops like Radish, Beetroot, Onion and leafy vegetables. Mustard (4:1) and maize					
		Trap crops & Attractants	Mustard, Marigold, Cowpea, Cluster Bean, Carrot, French Bean, Sunflower,					
		Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/**	**Pest management in Pupal stage**	**Pest management in Adult stage**

						Nymph stage		
1	Diamond back moth (DBM)	*Plutella xylostella*	Throughout the crop	**Egg**: Each female lays 50-60 small whitish eggs singly along the veins on underside of leaves at night times. Egg hatches in about 7 days. **Larva**: Larva is greenish with short thin hairs on the body. Full grown caterpillar measures 1-1.5 cm and its body tapers towards both ends. Larval period is 14 days. **Pupa**: Pupation takes place inside a thin loose mesh of silken cocoon. Pupal period is about 7 days **Adult**: The moth is greyish brown with narrow wings having pale white triangular markings on inner margin of each forewing which form three diamond shaped white patches dorsally when wings are folded over back at rest. Hence the name, diamondback moth.	1. Spraying of 5%NSKE solution	1. Inter crop with Mustard 2. Spraying of Chilli garlic extract	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)

2	Cabbage aphids	*Brevicoryne brassicae*	All stages	Nymphs and adults yellowish green with wavy white filament over the body	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection	1. Cleaning the field after the crop harvesting	Spraying of Vitex leaf decoction

3	Tobacco caterpillar	*Spodoptera litura*	All stages	**Eggs**: Female lays about 300 eggs in clusters. The eggs are covered over by brown hairs and they hatch in about 3-5 days. **Larva**: Caterpillar measures 35-40 mm in length, when full grown. It is velvety, black with yellowish – green dorsal stripes and lateral white bands with incomplete ring – like dark band on anterior and posterior end of the body. It passes through 6 instars. Larval stage lasts 15-30 days **Pupa**: Pupation takes place inside the soil. Pupal stage lasts 7-15 days. **Adult**: Moth is medium sized and stout bodied with forewings pale grey to dark brown in colour having wavy white crisscross markings. Hind wings are whitish with brown patches along the margin of wing. Pest breeds throughout the year. Moths are active at night. Adults live for 7-10 days. Total life cycle	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1.Erect bird perches @8 per acre 2.5%NSKE/Neem leaf extract during intial stage @ twice a week 3.Spray Chilli garlic based solution if pest is severe	1. Cleaning the field after the crop harvesting	Install 1 light traps & 10 pheromone traps per acre

				takes 32-60 days. There are eight generations in a year.				
4	Cabbage leaf webber	*Crocidolomia binotalis*		**Eggs**: Female moth lays eggs in masses of 40 -100 on underside of leaves. They hatch in 5 -15 days **Larva**: Caterpillar webs together the foliage and feeds on leaves. It also feeds on flowers and pods in the case of mustard and flower heads in cabbage and cauliflower. Caterpillar bears red head with brown longitudinal stripes and rows of tubercles on the body. Larval period is 24-27 days. **Pupa**: Pupation takes place in a cocoon within the webbed leaves. Pupal period is 14-40 days. **Adult**: Adult is small with light brownish forewings.	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1.Erect bird perches @8 per acre 2.5%NSKE/Neem leaf extract during intial stage @ twice a week (Melia azadirach can be used if neem is not available) 3.Spray Chilli garlic based solution if pest is severe	1. Cleaning the field after the crop harvesting	Install 1 light traps & 10 pheromone traps per acre

5	Cabbage head borer	*Hellula undalis*		**Egg**: Yellow shiny eggs laid on the leaves **Larva**: Full grown larva are greyish-yellow with seven purplish brown longitudinal stripes **Adult**: Pale greyish brown moth with wavy grey markings	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1. Collect and destroy mechanically caterpillars in the early stages of attack 2. Spraying solution of Bacillus thuringiensis @2gm/lit at premordial stage	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
6	Cabbage butterfly	*Pieris brassicae*		**Larva**: The caterpillar is velvety green and measures about 4.2 cm in length. The caterpillars are gregarious initially but disperse as they grow. **Pupa**: Pupation is in damaged leaves. **Adult**: Adult is a butterfly with its fore wings snow white having black distal margins. Hind wings pure white with black apical spots.	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)

Cotton crop - Insect Pest Management in Natural Farming								
Background - Cotton is a major fiber crop in India, predominantly grown in the Kharif season. Bollworms, whiteflies, and aphids are significant pests. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice								
Suggested multi-crops		**Inter Crops**	Tuber crops like Raddish, Beetroot, Onion and leafy vegetables. Mustard (4:1) and maize					
		Trap crops & Attractants	Mustard, Marigold, Cowpea, Cluster Bean, Carrot, French Bean, Sunflower,					
		Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**
1	Jassids (Leaf hoppers)	*Amrasca (Biguttula biguttula)*	Vegetative stage	**Eggs –** Greenish transparent eggs are deposited in the midrib of leaf blade or sheath of rice or green grass. They are laid in batches of 10 to 15 arranged in a single row. **Nymph -** The nymphs are soft bodied, yellow white in colour. Gradually the colour changes to green with five nymphal instars and become adults in	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. 1 Light trap per acre 2. Yellow sticky traps @ 20 -25/acre 3. Spraying of Nirgundi/ neem leaf extract (Melia azadirach can be used if neem is not		Spraying of Nirgundi leaf extract

				18-20 days. **Adult** - Adults are 3-5 mm long, bright green with variable black markings, wedge shaped with a characteristic diagonal movement.		available)		
2	White fly	*Bemisia tabaci*	Vegetative stage to Fruiting stage	**Eggs –** Are pear-shaped (approximately 0.2 mm long), with a gleaming white color that darkens over time **Nymph**- Whitish-yellow nymphs turn yellowish and dome-shaped after feeding. The pale yellow freshly molted third instar nymphs, however, gradually turn dark yellow and more flattened in shape after feeding **Adult** - Yellow-bodied with a pair of white wings that form an inverted V-shape covering the thorax and abdomen	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection		Spraying of Vitex leaf decoction
3	Thrips	*Thrips tabaci*	Vegetative stage	**Nymph**- Yellowish **Adult** - Dark coloured with fringed wings	Grow Marigold as Trap crop	1. Blue sticky traps @4-5 /acre 2.5% NSKE/Neem leaf extract with soap solution (Melia azadirach can be used if	Pupation takes place in the leaf folders. Collect them and destroy	Spraying of 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if

						neem is not available)		neem is not available)
4	Tobacco caterpillar	*Spodoptera litura*	All stages	**Eggs**: Female lays about 300 eggs in clusters. The eggs are covered over by brown hairs and they hatch in about 3-5 days. **Larva**: Caterpillar measures 35-40 mm in length, when full grown. It is velvety, black with yellowish – green dorsal stripes and lateral white bands with incomplete ring – like dark band on anterior and posterior end of the body. It passes through 6 instars. Larval stage lasts 15-30 days **Pupa**: Pupation takes place inside the soil. Pupal stage lasts 7-15 days. **Adult**: Moth is medium sized and stout bodied with forewings pale grey to dark brown in colour having wavy white crisscross markings. Hind wings are whitish with brown patches along the margin of wing. Pest breeds throughout the year. Moths are active at	1. Trap crops 2. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1.Erect bird perches @8 per acre 2.5%NSKE/Neem leaf extract during intial stage @ twice a week (Melia azadirach can be used if neem is not available) 3.Spray Chilli garlic based solution if pest is severe	1. Cleaning the field after the crop harvesting	Install 1 light traps & 10 pheromone traps per acre

				night. Adults live for 7-10 days. Total life cycle takes 32-60 days. There are eight generations in a year.				
5	American boll worm	*Helicoverpa armigera*	Vegetative to Reproductive stage	**Eggs**: Sub-globular, yellowish white in colour. Laid singly on shoots, buds, bracts tender bolls. Egg period: 4-7 days. **Larva**: Greenish brown with brownish grey lines and dark grey yellow stripes on lateral sides. Larval period: 5-18 days. **Pupa**: Brown coloured. Pupation in soil. Pupal period: 10-14 days. **Adults**: Stout- yellowish brown with 'V' shaped speck, greyish wavy lines and black mark on forewings Hind wings whitish with brown or black border along outer margin, Adult longevity: 10-12 days .	1. Cleaning the field after the crop harvesting	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)

6	Pink boll worm	*Pectinophora gossypiella*	Vegetative to Reproductive stage	**Egg**: Flat, laid singly on leaves, flowers, bolls. Egg period 4-20 days. **Larva**: Young larva are white and late instar becomes almost black, brown or green to pale or pink. Larval period: 25-35 days. **Pupa**: Pupation in soil and debris. Pupal period: 8-12 days. **Adult**: Small moth. Forewings are brown or dull yellow olive grey with dark spots. Hind wings margins are deeply fringed. Adult longevity: 7-10 days.	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
7	Red cotton bug	*Dysdercus cingulatusi*	Vegetative stage	**Nymphs and Adults -** Reddish bugs with white bands on the abdomen and black markings on the wings		1. Hand picking or shaking the plants 2. Spraying of Neem leaf extract (Melia azadirach can be used if neem is not available)		Spraying of Neem leaf extract (Melia azadirach can be used if neem is not available)

Brinjal crop - Insect Pest Management in Natural Farming
Background - Brinjal, a key vegetable in Indian diets, is grown across various seasons. Shoot and fruit borers are major pests reducing yield. The

pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice								
Suggested multi-crops		**Inter Crops**	Tuber crops like Raddish, Beetroot, Onion and leafy vegetables. Mustard (4:1) and maize					
		Trap crops & Attractants	Mustard, Marigold, Cowpea, Cluster Bean, Carrot, French Bean, Sunflower,					
		Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**
1	Fruit and Shoot borer	*Leucinodes orbonalis*	Vegetative stage	**Eggs**: Creamy white eggs **Larva**: Pink in colour **Pupa**: Greyish boat shaped cocoon **Adult**: Medium sized moth. Forewings has black and brown patches and dots on white colour, hind wings are opaescent with black dots	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)

2	Stem borer	*Euzophera perticella*	Vegetative stage	Egg: Cream, scale-like Larva: Fully grown larva is creamy white Adult: Greyish brown, forewings has transverse line and hind wings are white in colour	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
3	Hadda / spotted beetle	*H.vigintioito punctata*	Vegetative stage	Eggs: Cigar shaped, yellow in colour Grub: Yellowish bearing six rows of longitudinal spines Pupa: Yellowish with spines on posterior part and anterior portion being devoid of spines. Adult: 14 spots on each elytra, deep red	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Hand picking or shaking the plants 2. Spraying of Chilli garlic extract	1. Cleaning the field after the crop harvesting	Manual collection or collection with insect net and killing of adults in kerosenized water is the only possible solution.
4	Brown leaf hopper	*Cestius phycitis*	Vegetative stage	Adult: Small light brown leaf hopper	1. Egg eating insects 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is	1. Increase the activity of Predators, parasitoids like Lace wing, Lasdy bird beetle 2. Spraying of Soil		1. Avoid close planting 2. Spraying of Chilli garlic based solution

					not available)	solution at intial stages 3. Spraying of Chilli garlic based solution		
5	Lace wing bug	*Urentius hystricellus*		Egg: White nibble shaped eggs Nymph: yellowish white with prominent spines Adult: Dorsal side -straw coloured Ventral side -black coloured Pronotum and forewings reticulated		1. Hand picking or shaking the plants 2. Spraying of Neem leaf extract (Melia azadirach can be used if neem is not available)		Spraying of Neem leaf extract (Melia azadirach can be used if neem is not available)

Beans crop - Insect Pest Management in Natural Farming		
Background - Beans, including French beans and cluster beans, are commonly grown in Kharif and Rabi seasons. Aphids, thrips, and pod borers are prevalent pests. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice		
Suggested multi-crops	**Inter Crops**	Tuber crops like Raddish, Beetroot, Onion and leafy vegetables. Marigold, Castor
	Trap crops & Attractants	Cowpea, Sunflower, Carrot, Alfalfa, Mustard, Coriander, Fenugreek, Fennel
	Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop

Sno	Pest name	Scientific name	Incidence at crop stage	Identification of the pest	Pest management in Egg stage	Pest management in larval stage/ Nymph stage	Pest management in Pupal stage	Pest management in Adult stage
1	Bean Aphids	*Aphis craccivora*	All stages	**Nymph & Adult** - Reddish to dark brown coloured with cornicles in the abdomen	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neemastra with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection	1. Cleaning the field after the crop harvesting	Spraying of Vitex leaf decoction
2	Thrips	*Thrips palmi*	Vegetative stage	**Nymph**- Yellowish **Adult** - Dark coloured with fringed wings	Grow Marigold as Trap crop	1. Blue sticky traps @4-5 /acre 2.5% NSKE/Neem leaf extract with soap solution (Melia azadirach can be used if neem is not available)	Pupation takes place in the leaf folders. Collect them and destroy	Spraying of 5% NSKE/Neem leaf extract with during initial stage

3	Fruit borer	*Helicoverpa armigera*	Vegetative to Reproductive stage	**Eggs**: Sub-globular, yellowish white in colour. Laid singly on shoots, buds, bracts tender bolls. Egg period: 4-7 days. **Larva**: Greenish brown with brownish grey lines and dark grey yellow stripes on lateral sides. Larval period: 5-18 days. **Pupa**: Brown coloured. Pupation in soil. Pupal period: 10-14 days. **Adults**: Stout- yellowish brown with 'V' shaped speck, greyish wavy lines and black mark on forewings Hind wings whitish with brown or black border along outer margin, Adult longevity: 10-12 days .	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
4	Red spider mite	*Tetranychus spp.*	Vegetative stage	**Eggs** – Hyaline, globular laid in mass **Nymphs** - Yellowish in colour **Adult** - Red coloured small sized	1. Trap crops	1. Destroy the infected parts 2. Spraying of Cow urine+Dung Asafoetida solution		1. Destroy the infected parts 2. Spraying of Cow urine+Dung Asafoetida solution

5	White fly	*Bemisia tabaci*	Vegetative stage to Fruiting stage	**Eggs** – Are pear-shaped (approximately 0.2 mm long), with a gleaming white color that darkens over time **Nymph**- Whitish-yellow nymphs turn yellowish and dome-shaped after feeding. The pale yellow freshly molted third instar nymphs, however, gradually turn dark yellow and more flattened in shape after feeding **Adult** - Yellow-bodied with a pair of white wings that form an inverted V-shape covering the thorax and abdomen	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection		Spraying of Vitex leaf decoction

Citrus crop - Insect Pest Management in Natural Farming		
Background - Citrus fruits like oranges, lemons, and sweet limes are widely grown in India, particularly in tropical and subtropical regions. Pests like citrus psylla, fruit flies, and leaf miners are of major concern. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice		
Suggested multi-crops	**Inter Crops**	Tuber crops like Radish, Beetroot, Onion and leafy vegetables. Mustard (4:1) and maize
	Trap crops & Attractants	Mustard, Marigold, Cowpea, Cluster Bean, Carrot, French Bean, Sunflower, Maize
	Border	Teak, Sesbania, Gliricidia

		crops						
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**
1	Aphid	*Toxoptera aurantii*	Fruiting stage	**Nymph & Adult** - Reddish to dark brown coloured with cornicles in the abdomen	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf decoction at severe infection	1. Cleaning the field after the crop harvesting	Spraying of Vitex leaf decoction
2	Citrus psylla	*Diaphorina citri*	Fruiting stage	**Nymphs**: Are flattened, oval in shape with orange colour **Adult**: Minute insect, shiny black with grey dusting on the body, wings are extending beyond the tip of the abdomen		1. Yellow sticky traps @8 per acre 2. Collect and destroy the infested plant parts 3. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available)		

3	Citrus leaf miner	*Phyllocnistis citrella*	Fruiting stage	**Eggs**: Are minute, flattened presence on the lower side of the midrib **Larvae**: Minute, yellowish or reddish and apodous settled down on the edge of the folded leaves **Adult**: Minute moth, black spot at the tip of the fore wing	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids like Spider, Dragon fly 2. Placing Bird perches @8/acre 3. Spraying of Chilli garlic extract - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not available)
4	Mealybug	*Planococcus citri*	Fruiting stage	**Eggs**: Are laid in clusters, protective cottony mass **Nymphs**: Are amber coloured with white waxy coating with filaments **Adult**: Male is winged, long antenna and without mouth parts. Female is wingless, flat body and short, waxy filaments along the margins		1. Spray 5% NSKE solution or neem leaf extract (Melia azadirach can be used if neem is not available)		1. Spray Vitex leaf solution 2. Apply sub soil mixed with water

5	Fruit sucking moth	*Eudocima fullonica*	Fruiting stage	**Larva**: orange blue and yellow spots on velvety dark speckled on the body **Adult**: stout moth and orange coloured wing and three black spots on the fore wing	1. Trap crops 2. Hand picking and destroying eggs/egg mass 3. Egg eating insects 4. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Collection and destruction of rotten and dropped fruits. 2. Collection and destruction of moths during night time using battery or flame torch in addition to installation of one fluorescent light trap/acre before one month of fruit maturation between 7.00 PM and 11.00 PM.	1. Cleaning the field after the crop harvesting	1. Destruction of larval hosts (alternate host) around orchards. 2. Place fruit fly traps 3. Light traps @ 5 per acre before fruiting stage
6	Citrus/Lemon butterfly	*Papilio demoleus*	Fruiting stage	**Larva**: Early stage larva resembles bird dropping. Grown up larva are cylindrical, stout, green and brown lateral bond **Adult**: Dark brown swallowtail butterfly with numerous yellow marking	1. Trap crops 2. Hand picking and destroying eggs/egg mass 3. Egg eating insects 4. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution (Melia azadirach can be used if neem is not

								available)

Sugarcane crop - Insect Pest Management in Natural Farming								
Background - Sugarcane is a leading cash crop in tropical and subtropical India. Early shoot borers, top borers, and termites are key pests. The pests mentioned are having national and regional importance.The assumption here is that these plants are available everywhere								
Suggested multi-crops		**Inter Crops**	Pulses (Green gram, Black gram)Cow pea, Field bean, French bean, Chilli, Onion and Garlic, Cabbage and Cauliflower					
		Trap crops & Attractants	Mustard, Marigold, Cowpea, Cluster Bean, Carrot, French Bean, Sunflower, Chrysanthemum, Maize					
		Border crops	Sesbanaia, Glyricidia					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**
1	Shoot borer	*Chilo infuscatellus*	Tillering stage	**Egg**: Flat – scale like eggs are laid in 3-5 rows on the lower surface of leaves in masses of 4-100. The masses are slightly overlapping like tiles. **Larva**: Larva is dirty white with five dark violet longitudinal stripes and dark brown head. **Pupa**: Pupation takes within the tunnel. Caterpillar before pupating makes a large exit	1. Trap crops 2. Hand picking and destroying eggs/egg mass 3. Egg eating insects 4. Spraying 5% Neem seed kernel extract / Neem leaf extract solution	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Intercrop with cowpea in 2:1 ratio 4. Spraying of Agniastra - 3 litres	1. Cleaning the field after the crop harvesting	1. Install 1 light traps & 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution @100 liter/acre (

				hole in the stem and blocks the opening with silken discs. **Adult**: Pale greyish brown moth with black dots near the coastal margin of the forewings and with white hind wings.	100 liter/acre (Melia azadirach can be used if neem is not available)	in 100 litres of water/acre		Melia azadirach can be used if neem is not available)
2	Top shoot borer	*Scirpophaga excerptalis*	Tillering stage	**Egg**: Eggs are laid on the lower surface of top leaves in clusters particularly near midribs. The clusters are covered with buff coloured hairs. **Larva**: Smooth, white or cream coloured with a red coloured mid – dorsal line and yellow head. **Pupa**: Pupation takes place within the larval tunnel in a chamber with an exit hole constructed by the caterpillar. **Adult**: White Coloured moth (with a buff orange coloured anal tuft of hairs in female)	1. Trap crops 2. Hand picking and destroying eggs/egg mass 3. Egg eating insects 4. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Chilli garlic based solution	1. Cleaning the field after the crop harvesting	1. Install 1 light traps & 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution @100 liter/acre (Melia azadirach can be used if neem is not available)

3	Internode borer	*Chilo sacchariphagus*	Cane formation	**Egg**: Scale – like white eggs are laid by female moths in batches of 9-11, near the midribs, on leaf sheaths or on stem. **Larva**: White larva with four violet longitudinal stripes and light brown head. **Pupa**: Pupation takes place in semi – dried sheath. Pupal period 7-10 days. **Adult**: Straw coloured with a dark spot on each of the fore wings.	1. Trap crops 2. Hand picking and destroying eggs/egg mass 3. Egg eating insects 4. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Chilli garlic based solution	1. Detrash the crop on 150th and 210th day of planting. Detrashing dislodge the pupae that remain in the leaf sheath.	1. Install 1 light traps & 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution @100 liter/acre (Melia azadirach can be used if neem is not available)
4	White woolly aphid	*Ceratova cuna lanigera*	Tillering stage	**Nmph :** These are yellowish white in colour with less powdery substance. **Adult :** Two forms of adult viz., apterate and alate. The Alate forms are predominantly white in colour. Apterate often possesses crenulated margins of wax glands in rows. Such wax glands are absent in alate. Adult emerge after fourth moult and viviparous reproduction. Apterous (Wingless) females reproduce	Clipping of infested leaves.	1. Paired row system of planting. 2. Avoid excessive use of nitrogenous fertilizers. 3. Rapping of canes all along the rows. 4. Infested tops should not be transported.	Wrapping of canes	1. Infected canes should not be used as planting material 2. Paired row system of planting 3. Spray VItex leaf solution 4. Spray Datura leaf extract during severe infection

				parthenogenetically. Each female produced about 15 – 35 young ones. Each female reproduces a maximum of 217 nymphs with more females, which leads to fast multiplication. Nymph takes 6 to 22 days to complete four instars and become an adult.				
5	White fly	*Aleurolobus barodensis*	Cane formation	**Egg**: Females lay eggs in a line near the midrib or anywhere on the lower surface of the leaves. Eggs are yellowish with a small curved stalk. Colour changes to black about two hours after the eggs are laid. **Nymph & Pupa**: Neonate nymphs are pale yellow in colour, flat and oval in shape, later turn shiny black. Its body is surrounded by fringes of wax.The fourth instar being the pupal stage, is flat, oval, greyish in colour and slightly bigger than the nymph. There is a 'T' shaped white marking on the thorax, which splits at the time of adult emergence. **Adult**: Pale yellow body with	1. Trap crops 2. Hand picking and destroying eggs/egg mass 3. Egg eating insects 4. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Detrashing of cane at the 5th and 7 th month 3. Yellow sticky traps @ 20-25 per acre 4. Spray 5% NSKE	1. Cleaning the field after the crop harvesting	1. Install 1 light traps & 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution @100 liter/acre (Melia azadirach can be used if neem is not available)

				hyaline wings dusted with waxy bloom, exhibit brisk fluttering movements.				
6	Mealy bug	*Saccharicoccus sacchari*	Cane formation	**Eggs**: Eggs are retained in the female reproductive organs until they fully mature. Incubation period is short. The females may bring forth hundreds of young ones parthenogenetically. Egg is yellowish, smooth, cylindrical and rounded at both ends. **Nymph**: Newly emerged nymphs are quite active with a pinkish transparent body. **Adult**: Pinkish with mealy coating.		1. Spray 5% NSKE solution or neem leaf extract (Melia azadirach can be used if neem is not available)		1. Spray Vitex leaf solution 2. Apply sub soil mixed with water

7	Pyrilla (Hopper)	*Pyrilla perpusilla*	Cane formation	**Egg**: Females lay eggs on the lower, shady and concealed side of the leaves near the midrib. Eggs are laid in clusters of 30-40 in numbers in rows of 4-5. They are covered by pale waxy material. Eggs are oval-shaped, pale whitish to bluish green when laid and turn brown just before hatching. A female lays 600 - 800 eggs in her lifetime. **Nymph**: Nymph passes through five nymphal instar stages to reach adult stage. The following table gives the information about the features of each instar nymph **Adult**: Just after molting, the adults are white colored but later their body turns straw colored, eyes turn pale green and head develops a snout with a black spot at the posterior side. The anterior area has numerous minute black spots.	1. Removal and destruction of white coloured puffy pyrilla egg masses or egg bearing leaves at regular intervals 2. Collect egg masses in a cloth bag and keep them at random places for egg parasitoids	1. Spray diluted cow urine solution 2. Spray ipomea leaf solution		Spray Metarhizium anisopliae (Bio pesticide)

Pea crop - Insect Pest Management in Natural Farming

Background - Pea is a major Rabi crop in cooler regions. Pod borers and aphids pose significant challenges. The pests mentioned are having national and regional importance.The assumption here is that the resources are readily available and easy to practice								
Suggested multi-crops		**Inter Crops**	Tuber crops like Radish, Beetroot, Onion and leafy vegetables. Mustard (4:1) and maize					
		Trap crops & Attractants	Mustard, Marigold, Cowpea, Cluster Bean, Carrot, French Bean, Sunflower,					
		Border crops	4 rows of Jowar or Bajra or Maize before sowing the main crop					
Sno	**Pest name**	**Scientific name**	**Incidence at crop stage**	**Identification of the pest**	**Pest management in Egg stage**	**Pest management in larval stage/ Nymph stage**	**Pest management in Pupal stage**	**Pest management in Adult stage**
1	Pea pod borer	*Helicoverpa armigera*	Vegetative to fruiting stage	**Eggs**: Sub-globular, yellowish white in colour. Laid singly on shoots, buds, bracts tender bolls. Egg period: 4-7 days. **Larva**: Greenish brown with brownish grey lines and dark grey yellow stripes on lateral sides. Larval period: 5-18 days. **Pupa**: Brown coloured. Pupation in soil. Pupal period: 10-14 days. **Adults**: Stout- yellowish brown with 'V' shaped speck, greyish wavy lines and black mark on forewings Hindwings whitish	1. Trap crops 2. Hand picking and destroying eggs/egg mass 3. Egg eating insects 4. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids 2. Placing Bird perches @8/acre 3. Spraying of Dashparni - 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 1 light traps & 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution @100 liter/acre (Melia azadirach can be used if neem is not available)

				with brown or black border along outer margin, Adult longevity: 10-12 days .				
2	Stem fly	*Ophiomyia phaseoli*	Vegetative stage	**Eggs** : The female lays 14-64· elongate, oval and white eggs into the leaf tissue **Maggots** : The maggots bore into the stem **Adult** : The adult flies are metallic black.	1. Trap crops 2. Hand picking and destroying eggs/egg mass 3. Egg eating insects 4. Spraying 5% Neem seed kernel extract / Neem leaf extract solution 100 liter/acre (Melia azadirach can be used if neem is not available)	1. 5% NSKE/Neem leaf extract with soap solution (Melia azadirach can be used if neem is not available) 2. Fish meal traps @4 / acre	1. Cleaning the field after the crop harvesting	1. 5% NSKE/Neem leaf extract with soap solution (Melia azadirach can be used if neem is not available) 2. Spraying of Chilli garlic based solution
3	Pea Aphid	*Acyrthosiphon pisum*	Vegetative to Reproductive stage	**Reproduction is parthenogenetic and viviparous.** **Adult**: Adult aphids are soft bodied, long legged, pear-shaped, green yellow or pink in colour with long conspicuous cornicles	Conservation of natural enemies such Lady Bird Beetles,chrysoperla and syrphids	1. Yellow sticky traps @8 per acre 2. 5% NSKE/Neem leaf extract with during initial stage (Melia azadirach can be used if neem is not available) 3. Vitex leaf	1. Cleaning the field after the crop harvesting	Spraying of Vitex leaf decoction

						decoction at severe infection		
4	Leaf miner	*Chromatomyia horticola*	Vegetative to Reproductive stage	**Eggs** : Lays eggs singly, in leaf tissues **Adult** : The adults are two-winged flies having greyish black mesonotum and yellowish frons	1. Trap crops 2. 5% NSKE / Neem leaf extract (Melia azadirach can be used if neem is not available)	1. Increase the activity of Predators, parasitoids like Lace wing, Ladybird beetle 2. Placing Bird perches @8/acre 3. Spraying of Chilli garlic based solution- 6 litres in 200 litres of water	1. Cleaning the field after the crop harvesting	1. Install 1 light traps & 10 pheromone traps per acre 2.Planting trap crops on the bunds/borders 3.Spraying of Neem leaf solution @100 liter/acre (Melia azadirach can be used if neem is not available)

Annexure- XVII

Preparation and Application of commonly used Natural Farming bio-inputs prepared by ICAR - IIFSR

1. **Beejamrut (Beejamrutha or Bheejamrutham)** It is used for seed dressing or dipping seedling roots. Seed dressing involves coating seeds with beejamrut before sowing and drying them in the shade. The application of beneficial microbes to seeds effectively places microbial inocula in the soil, positioning them to colonize seedling roots and protect them against soil-borne diseases and pests.
    a. **Ingredients Used**
        i. Water - 20 Litre
        ii. Cow Dung - 5 Kg
        iii. Cow Urine - 5 Litre
        iv. Lime - 50 gram
        v. Rhizospheric Soil - Handful
    b. **Preparation**
        i. Take 5 kg desi Cow dung and wrap it in a cotton cloth.
        ii. Take 20 litre water in a bucket and dip the above 5 kg cow dung wrapped in cloth into it.
        iii. Leave it for 12 to 16 hours so that the cow dung extract may come into the water.
        iv. Take 50gm lime in another container having 1 litre water
        v. Now mix the above two preparations and into it add 50gm rhizospheric soil.
        vi. Add 5 liters of cow urine into it and leave the solution prepared for 8-12 hours.
        vii. Now the beejamrut is ready for seed treatment.
    c. **How to Use?**
        i. Add beejamrut to the seeds of any crop; coat them, mixing by hand; dry them well and use them for sowing. For leguminous seeds, which may have thin seed coats, just dip them quickly and let them dry.
    d. **Benefits**
        i. Increase Viability of Seeds improve seed germination, shoot and root length, seedling vigor, and crop performance. beejamrut promotes root dry weight and root proliferation, enhancing nitrogen, nutrient, and water uptake by crop plants.
        ii. Prevents Seed Borne Diseases.

Nutrient content range (Ravisankar et al., 2024) and Microbial population (AINP centre, Udaipur;2021-22) observed is given below.

Parameter	Unit	Value
Nitrogen	%	0.72-2.38
Phosphorus	%	0.12-0.14
Potassium	%	0.23-0.49
Bacteria count	CFU/ml (x108)	5.37-6.10
Fungal count	CFU/ml (x104)	3.42 -4.05
Actinomycetes count	CFU/ml (x105)	2.90 -3.85

2. **Ghan Jeevamrut**: Ghan Jeevamrut is solid in form and is prepared using ingredients such as desi cow dung (150 kg), jaggery (1 kg), pulse flour (2 kg), virgin fertile soil for microbial culture (50-100g), native/desi cow's urine as required.
    a. **Method 1:** Mix well cow dung, jaggery, pulse flour and soil. Add a little bit of cow urine to it as needed. Dry the mixture in shade for 2-4 days. Use in the field after drying and grinding well into small aggregates. It can be stored and used for 6 months.
    b. **Method 2:** Take 1-1.5 quintal well rotten desi cow dung manure and sprinkle 8-10 liters of jeevamrut on it. Mix well and use by broadcasting uniformly in the field. After preparing, keep it covered in the shade. It can be used for 6 months.
    c. **Method 3:** Take 1.5 quintals of dry biogas slurry, a kilogram of jaggery, 2 kilograms of pulse flour and a handful of virgin soil. Mix these well and broadcast uniformly in the field. Ghan jeevamrut can also be prepared by sprinkling jeevamrut solution on this slurry as per requirement. If ghan jeevamrut is prepared by adding jeevamrut solution, then there is no need to add jaggery, pulse flour and soil separately.
    d. **Method 4** (Best quality method): Make a pile of fresh cow dung partially dried up to 3-4 days up to a height of 1.5 feet. Size of the pile might be as per convenience (say 12x3 feet). Make holes with a wooden log at a distance of about 1 feet and fill up these holes with already prepared jeevamrut. Turn the dung pile up and down after one week. Then again make the holes and fill up these holes with jeevamrut and turn up the pile again after one week. This way this process is repeated 2-3 times. The

Ghan jeevamrut will be ready in 30-35 days. Then after pounding it in small sized particles, it can be broadcasted uniformly in the field or stored in shade after covering with gunny bags. Generally, it is recommended to use 800 to 1000 kg per acre of land as a basal dose. However, this can be applied as top dressing also as per crop duration.

Nutrient content range (Ravisankar et al., 2024) and Microbial population (AINP centre, Udaipur;2021-22) observed is given below.

Parameter	Unit	Value
Nitrogen	%	1.05-1.80
Phosphorus	%	0.16-0.30
Potassium	%	0.68-0.85
Bacteria count	CFU/ml (x108)	29.65-30.52
Fungal count	CFU/ml (x104)	5.98-6.88
Actinomycetes count	CFU/ml (x105)	4.01-4.86

3. **Jeevamrut (Jivamrita or jeevamruta or Jeevamrutha or Jeevamrutham):**
   Jeevamrut is a fermented microbial culture made from on-farm ingredients. During fermentation, aerobic and anaerobic bacteria in cow dung and urine multiply as they decompose the organic ingredients. jeevamrut acts as a catalyst, promoting soil microorganism activity, including earthworms, and making nutrients available to crops. Indigenous cow dung and urine produce the best jeevamrut due to higher beneficial microbial populations.
   a. **Ingredients Used**
      i. Water - 200 Litre
      ii. Fresh Cow Dung - 10 Kg
      iii. Cow Urine - 10 Litre
      iv. Jaggery - 2 Kg / 1.5 kg of cane jaggery (sugar)/ sweet fruit pulp
      v. Pulse Floor - 2 Kg
      vi. Rhizospheric virgin soil from banyan tree areas, forests, or termite mounds - Handful
   b. **Preparation**
      i. Take 200 litre water in a barrel for one acre farmland.
      ii. Add 10 litre cow urine preferably desi cow urine in the above barrel filled with water.
      iii. Add 10 kg Cow dung in the above solution.

iv. Add 2 kg Jaggery into the above solution.
v. Add 2 kg of Pulse flour preferably besan in the above solution.
vi. Add a handful of rhizospheric soil in the above solution.
vii. Stir all the above ingredients well using a wooden stick by rotating in a clockwise direction.
viii. Keep the barrel covered with a jute bag.
ix. Keep this solution quite stable for 48 hours for fermentation under shade.

c. How to Use:

i. Spray with water
ii. Along with irrigation water

d. Benefits

i. Soil fertility enhancer (applied along with irrigation water)
ii. Promoting growth and flowering along with acting as a yield enhancer (@5-10% spray with water)

Nutrient content range (Ravisankar et al., 2024) and Microbial population (AINP centre, Udaipur;2021-22) observed is given below.

Parameter	Unit	Value
Nitrogen	%	0.25-1.40
Phosphorus	%	0.13-0.42
Potassium	%	0.26-0.31
Bacteria count	CFU/ml (x108)	25.47-26.53
Fungal count	CFU/ml (x103)	1.82 – 2.75
Actinomycetes count	CFU/ml (x103)	4.97-5.88

4. **Brahmastra** Bramhastra is prepared by using 10 liters of desi cow urine and a paste of neem, Pongamia (karanj), custard apple, castor, and datura leaves (2 kg each). The manually crushed paste is boiled until frothing appears, filtered, and fermented for 48 hours in shade, stirred twice daily. Brahmastra is sprayed at 6–8 liters per 200 liters of water for one acre and effectively controls sucking pests, fruit borer, and pod borer.

a. Ingredients Used

i. Neem Leaves - 3 Kg
ii. Karanj Leaves - 2 Kg

iii. Custard Apple Leaves - 2 Kg
iv. Papaya Leaves - 2 Kg
v. Guava Leaves - 2 Kg
vi. Cow Urine - 10 Litre

b. Preparation

i. Take 10 liters of cow urine
ii. Add 03 kg of crushed green leaves of neem.
iii. Add 02 kg crushed Karanj Leaves.
iv. Add 02 kg crushed Custard Apple Leaves.
v. Add 02 kg crushed Papaya Leaves.
vi. Add 02 kg crushed Guava Leaves.
vii. Now dissolve all this mixture in cow urine and boil it.
viii. After 3-4 boils, take it down from the fire.
ix. Let it cool for 48 hours and then filter the solution with a cloth.
x. Now Solution is ready to spray on the crop.

c. How to Use : Brahmastra is sprayed at 6–8 liters per 200 liters of water for one acre

d. Uses : For the effective control of sucking pests, fruit borer, and pod borer..

e. Storage : After preparation, it should be used within one month.

Composition estimated at AINP centre, Coimbatore; 2023-24) is given below.

Parameters	Unit	Value
Organic C	%	0.67± 0.07
Total Phenolics	ppm	1351± 33
Total Flavonoids	ppm	73.3± 10.4
Total Tannins	ppm	32348± 733
Total Alkaloids	ppm	253± 7
Total Gibberellins	ppm	8066± 276

5. **Neemastra**
    a. **Ingredients Used**
        i. Neem Leaves - 5 Kg
        ii. Cow Urine - 5 Litre
        iii. Cow Dung - 1 Kg
        iv. Water - 100 Litre
    b. **Preparation**
        i. Take five kg of green leaves of neem or take five kg of dried fruits of neem and keep the leaves or fruits crushed.
        ii. Add this crushed neem or fruit powder in 100 liters of water.
        iii. Put 5 liters of cow urine in it and mix one kg of cow dung.
        iv. Ferment the mixture for 48-96 hours, stirring twice daily, and filter with cloth.
        v. Dissolve thrice a day and after 48 hours filter the solution with a cloth. Now spray on the crop.
    c. **Uses:** For the management of sucking insects and leaf-eating caterpillars.

Composition estimated at AINP centre, Coimbatore; 2023-24) is given below.

Parameters	Unit	Value
Organic C	%	0.92 ±0.03
Total Phenolics	ppm	1196 ±77
Total Flavonoids	ppm	508 ±13
Total Tannins	ppm	15659 ±354
Total Alkaloids	ppm	2.39 ±0.39
Total Gibberellins	ppm	8393 ±144

6. **Agniastra :**
    a. **Ingredients Used**
        i. Neem Leaves - 5 Kg
        ii. Green Chilli - 0.5 Kg
        iii. Garlic - 0.5 Kg
        iv. Cow Urine - 20 Litre
    b. **Preparation**
        i. Take 20 liters of cow urine
        ii. Add 5 kg of crushed green leaves of neem.
        iii. Add 0.5 kg crushed Green Chilli.
        iv. Add 0.5 kg crushed Garlic.

v. Now dissolve all this mixture in cow urine and boil it.
vi. After 3-4 boils, take it down from the fire.
vii. Let it cool for 48 hours and then filter the solution with a cloth.
viii. Now Solution is ready to spray on the crop.

c. **How to Use :** Agniastra is sprayed at 4 - 6 liters per 200 liters of water for one acre
d. **Uses :** For insects living in tree trunks or stalks, all types of large bollworms and caterpillars.

7. **Dashparni Extract**
   a. **Ingredients Used**
      i. Crush neem leaves 5 kg,
      ii. Vitex negundo leaves 2 kg,
      iii. Aristolochia leaves 2 kg,
      iv. Papaya Leaves 2 kg,
      v. Tinospora cordifolia leaves 2 kg,
      vi. Custard apple leaves 2 kg,
      vii. Karanj leaves 2 kg,
      viii. Castor leaves2 kg,
      ix. Nerium indicum 2 kg,
      x. Calotropis procera leaves 2 kg,
      xi. Green chili paste 2 kg,
      xii. Garlic Paste 250 gm,
      xiii. Cow Dung 3 Kg,
      xiv. Cow Urine 5 liter
   b. **Preparation**
      i. Take 200 liters of water.
      ii. Add all above ingredients to it.
      iii. Let it ferment for one month and then filter the solution with a cloth.
      iv. Now Solution is ready to spray on the crop.
   c. **Use :** 2-3% Spray with water
   d. **Use:** All types of sucking pests and for control of all caterpillars.

8. **Sour butter milk**
   a. **Ingredients used**
      i. Sour buttermilk - 3 liters
      ii. Water - 100 liters
   b. **Preparation :** Mix buttermilk and water together in the above mentioned ratio
   c. **Use** : Spray the solution on the crop without diluting.

d. **Benefits :** This is effective against fungal diseases

9. **Saptdhanyankur**
    a. **Ingredients used**
        i. Wheat
        ii. Barley
        iii. Green Gram
        iv. Black Gram
        v. Chickpea
        vi. Finger Millet
        vii. Pearl Millet
    b. **Preparation**
        i. **Cleaning**: Wash all seven grains thoroughly to remove impurities.
        ii. **Soaking**: Soak them in clean water overnight (8–12 hours).
        iii. **Sprouting**: Drain the water and tie the soaked grains in a cotton cloth. Keep them in a warm, dark place for 24–48 hours to sprout.
        iv. Once sprouted, make a paste of all the seeds.
        v. Mix the paste in 200 litres of water by hand and also mix the previously steeped water.
        vi. Leave this mixture for 2 hours
        vii. After 2 hours, shake the mixture and stain it through a cloth.
        viii. This mixture should be sprayed within 48 hours of preparation.
    c. **Benefits**
        i. The solution is used to give lustre and shine on fruits, vegetables and grains.

10. **Sontashtra**
    a. **Ingredients used**
        i. Water - 2 liters
        ii. Ginger Powder - 200 grams
        iii. Cow milk - 2 liters
    b. **Preparation**
        i. Take 2 litres of water, add 200 grams of ginger powder (Sonth) and mix it and cover with a lid.
        ii. Now boil it till it reduces to half of the solution. Keep this solution for cooling.
        iii. Take 2 liters of desi cow milk in another container and boil it slowly on low flame.
        iv. After boiling milk, allow it to cool down, remove the cream from the milk.

v. Now take 200 litres of water, add a solution of ginger powder and milk without cream.
vi. Mix it properly and cover this solution with gunny bags for two hours.
vii. During this process ion exchange will occur, filter it with muslin cloth and spray this solution within 48 hours

c. Benefits : This is effective against fungal diseases

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Annexure- XVIII

List of few commonly use tools and implements in Natural Farming

1. Bullock drawn or tractor operated multicrop seed drill
2. Bullock drawn or tractor operated millet seed drill
3. Bullock drawn bed maker for ridge and furrow for kitchen garden or vegetables cultivation
4. Agnicart - bullock drawn cultivator
5. Battery operated single wheel weeder
6. Battery operated double wheel weeder
7. Battery operated paddy weeder
8. Battery operated Drava Jeevamrut and other bioinput sprayer