Standardised Sustainable Production Practices for Cumin

FARMERS' MANUAL

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This developPPP project aims to strengthen the production of cardamom (Kerala), Cumin and Dill seed (Rajasthan) turmeric (Tamil Nadu and Karnataka), Celery (Punjab and Haryana) by increasing the capacities of spice farmers and making the production practices economically, socially and environmentally more sustainable.

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As at December 2023

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This handbook is published under the Enhancement of Smallholder Spice Farmers' Capacities in Sustainable Farming Project, a part of the Indo-German Biodiversity Programme. It aims to create awareness among farmers regarding the sustainable production of cumin, ensuring the long-term viability of spice cultivation while minimising negative environmental and social impacts.

The project is funded through the develoPPP.de programme that the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH implements on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). GIZ India implements the project in cooperation with AVT McCormick Ingredients Pvt. Ltd. and McCormick Switzerland GmbH.

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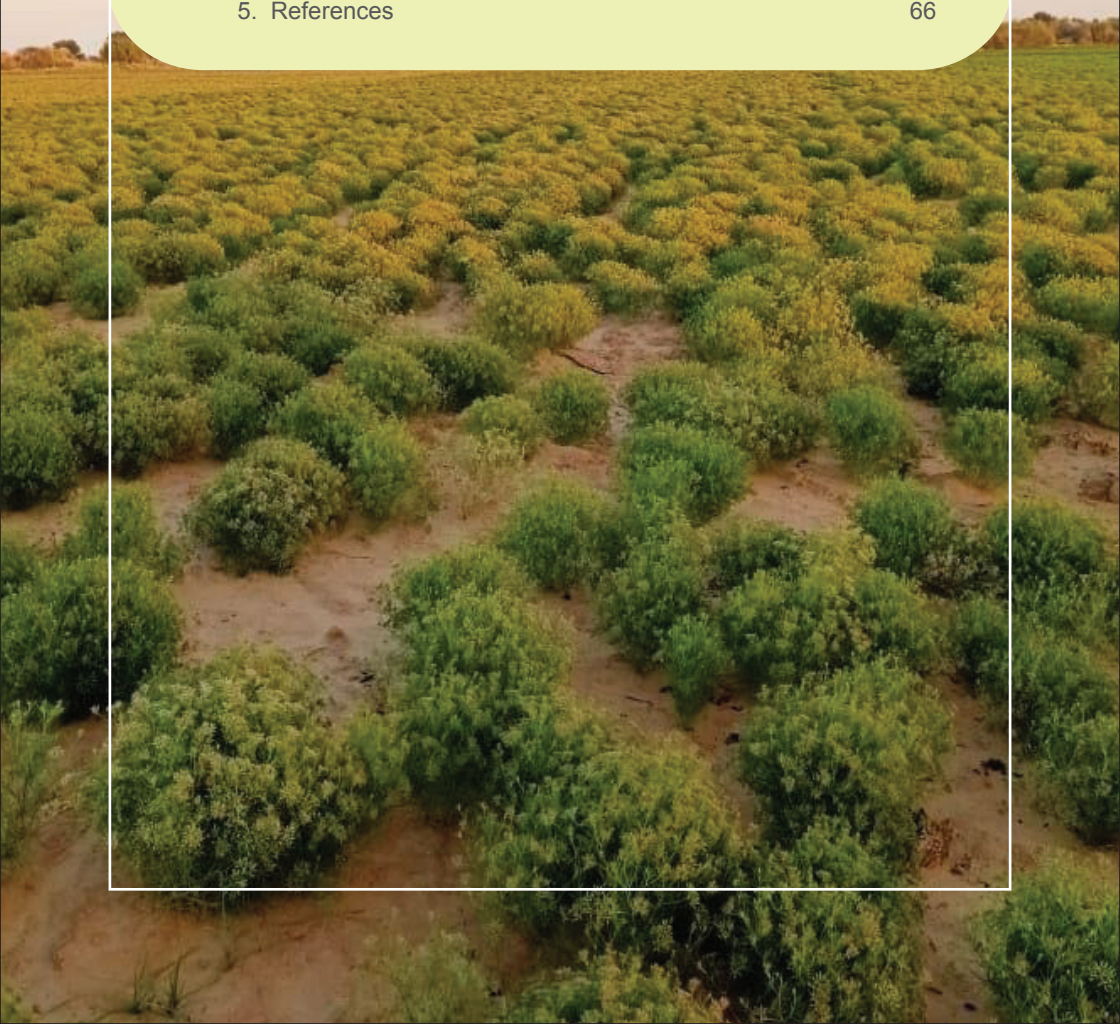


1 Why Sustainable Agriculture Practices

Why Sustainable Agriculture Practices

Background and Need for Sustainable Agriculture Practices

Historically, our soils were fertile and capable of producing adequate crop yields because there was enough water, either as rainfall or as irrigation. With the advent of Green Revolution, food production has drastically increased due to enhanced crop yields as a result of widespread adoption of technologies such as mechanisation, new high-yielding and disease-resistant crop varieties, irrigation, and especially the use of mineral fertilisers. The overall NPK consumption in India grew 11.84 times from 1970 -71 to 2018 -19. The consumption of fertiliser products increased from 50.6 Mt in the year 2009 to 61.4 Mt in 2020. However, the productivity (kg of food grain produced per unit of fertiliser nutrient used) exhibited a decline from 28 kg kg-1 in 1970-71 to 10 kg kg-1 in 2019-20. The overuse of mineral fertilisers accumulated mineral compounds in the soil which have been increasing the soil salinity and soil alkalinity, reducing the beneficial soil microorganisms.

The use of plant protection chemicals and weedicides has increased tremendously to control harmful insects, pests and weeds. The overuse of these agrochemicals for a longer duration impacts soil biodiversity and beneficial micro-organisms in agro-ecosystem negatively. It also leads to development of resistance to certain pests and insects in the crops. The impact on overuse of pesticides depends upon the type of pesticide used, and dose applied, but it affects the nutrient content and quality of the produce. Ultimately, we have now reached a stage where several threats are emerging on food security, human and environmental health, maintenance of ecological balance, and conservation of the soil biodiversity.

Major Challenges in Spices Cultivation

- Unseasonal rainfall and changes in the pattern of rainfall.
- Increased dependency of agriculture on agrochemicals.
- Overuse of mineral fertilisers over the last few decades, has deteriorated the land and water in the agroecosystem.
- Overuse of chemical pesticides.
- Decreased productivity as well as reduced quality of the produce.
- Decreased availability of irrigation water.
- Loss of biodiversity in the agroecosystem.
- Reduced water quality due to contamination of the water resources.
- Uncertain prices.
- Lack of awareness about consumer demands and limited access to market.

The current practices followed by the farmers are unsustainable, with regard to a) indiscriminate use of pesticides and improper dosages of fertilisers, b) improper methods in water irrigation, c) improper waste management, and d) inadequate post-harvest management and poor labour availability.

In India, small and marginal farmers with less than 2 hectares of land account for 86.2% of all farmers, but own just 47.3% of the arable land, according to provisional numbers from the 10th Agriculture Census 2015-2016. Average land holding in the country has reduced from 1.16 ha in 2012-13 to 1.1 ha in 2015-16 and is expected to reduce further in the future, with 67% of the farmers owning land less than 1.0 ha. Small land holdings and reduced yields due to climate change and insufficient knowledge about sustainable practices lead to decreased economic profitability and reduced production of quality produce. Further unsustainable farm practices create additional pressure on global issues such as climate change, loss of biodiversity, land degradation,

and pollution of soil and water. Thus, a major portion of the development efforts needs to be directed towards small and marginal land holders, who are dominating the agriculture sector in our economy.

Thus, the sustainable agriculture practices are playing a vital role in climate change adaptability and ensuring crop productivity with economic profitability. It is a method of cultivation which primarily aims at cultivating the land and raising crops in such a way, which keep the soil alive and in good health by use of farm wastes and other biological materials along with beneficial microbes (biofertilisers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution-free environment. More precisely, sustainable agriculture is based on managing the agro-ecosystem rather than relying on external farming inputs, such as pesticides, chemical fertilisers, additives, and genetically modified organisms.

These technologies are very cost-effective as it involves the use of locally available materials for protection of crops without compromising yield. It involves simple and reliable techniques that can be adopted by small and marginal farmers to increase their yield and profitability. Sustainable Agriculture involves following principles:

BUILDING SOIL STRUCTURE AND SOIL FERTILITY:

- Selection of crops and crop varieties.
- Crop rotation to enhance soil condition.
- Recycling of natural biomass by decomposition, to enhance soil organic carbon and soil microbial activities.
- Integrated Nutrient Management: Use of compost, vermicompost, green manures, Jeevamrut, biofertilisers as soil amendments for enhancing soil organic carbon and soil microbial activity to improve soil health and fertility.
- Intercropping, mixed cropping.
- Farming practices are carried out across the slopes to avoid soil erosion and land degradation.

CONSERVING SOIL AND WATER:

- Adoption of soil and water conservation measures like farm bunds, trenches, farming operations across the slopes, etc.
- Use of improved irrigation techniques to conserve water, like micro irrigation techniques.

MAINTAINING WATER QUALITY:

- Use of minimal and recommended agrochemicals to avoid water contamination of subsurface water.
- Managing pests ecologically by using biopesticides and minimal usage of synthetic pesticides (Integrated pest and disease management).
- Preventive and curative crop protection measures to reduce pest attacks on crops.

Preventive Measures:

- Soil solarisation.
- Appropriate land preparation activities.
- Cultivation of green manures, application of neem cake, vermi - composting to make soil productive.
- Providing proper drainage in the field to avoid water stagnation.
- Crop rotation, intercropping, mixed cropping
- Cultivation of trap crops.
- Appropriate seed treatment with biological formulations, beneficial microbes and fungi which help in better germination and healthy growth of plants.
- Maintaining appropriate crop geometry to increase crop resistance for better growth and development of crops.
- Spraying of natural growth promotors like Jeevamrut, Panchgavya, Amritpani at 30, 60 and 90 days after sowing.

- Relying on natural predators by installing bird perches to reduce pest attacks naturally.

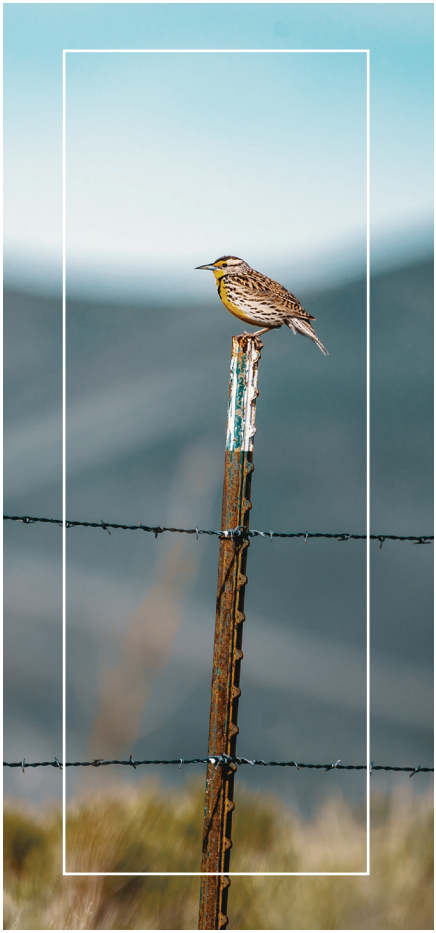
Curative Measures:

- Use of neem based biopesticides.
- Spraying biopesticides like Dashparni ark, Amrutpani.
- Minimal use of chemical pesticides: appropriate dosage, within permissible limits.

All these types of techniques are very cost effective and can be easily applied by small and marginal farmers to ensure their crop productivity with minimum inputs. All these techniques require natural ingredients which small and marginal farmers, with small amounts of livestock, can effectively use.

ENHANCING BIODIVERSITY IN THE FARM:

- Application of green manure, and organic manures will enhance soil biodiversity.
- Intercropping, mixed cropping.
- Use of trap crops and border crops
- Installation of bird perches, honeybee keepers, etc.
- Avoiding use of agrochemicals like mineral fertilisers, pesticides, etc.
- Integration of crop production system with livestock production, so that livestock wastes can be effectively used as manures.
- Integrated farming system is important for enhancing additional income of the farmers and reducing the dependency and cost of cultivation of the crops.



2 Overview of Spice Production in India

Overview of Spice Production in India

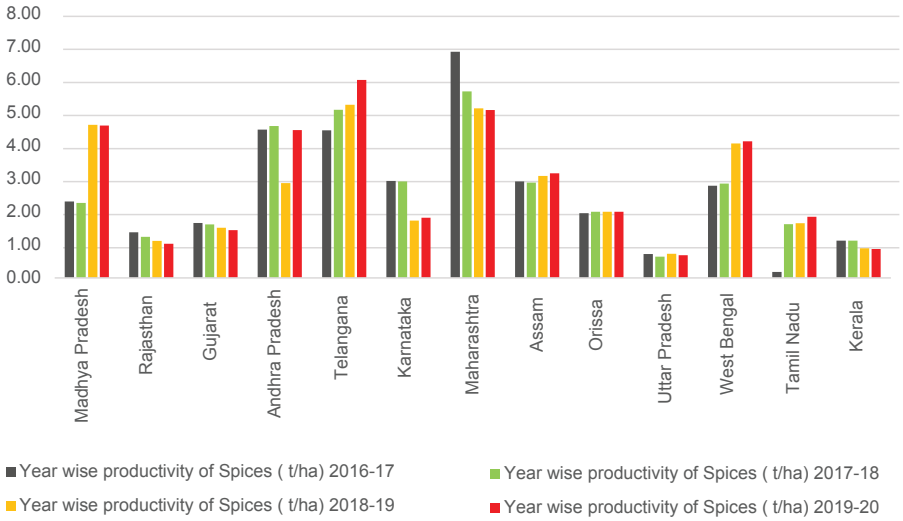
The demand for spices has tremendously increased during the pandemic period due to its medicinal properties and its role in enhancing immunity.

- Spices are seeds, fruits, roots, barks, or other plant substances used in different forms like fresh, dried and powdered. Spices are used to season and preserve food and as medicines, dyes, and perfumes.
- Spices have been highly valued as trade goods for thousands of years.
- The demand of spices has tremendously increased during the pandemic period due to its medicinal properties and its role in enhancing immunity. This can be clearly seen from the growing export of spices like turmeric, ginger, cumin, chilli etc.
- India is home to a wide variety of spices and holds a prominent position in world spice production. India is world's largest producer, consumer and exporter of spices as most of the states and union territories in India grow one or the other spices.
- India is unique in this regard as it is bestowed with wide variations in climatic conditions from tropical to subtropical, to temperate, which allow the growth of all spices splendidly in India.
- Traditionally, spices in India have been grown on small land holdings that support the rich culinary culture of India.
- Spices provide a prime source of livelihood to millions of smallholder farmers in India. About 85% of the spice production in India is led by small-scale producers, who typically have farm holdings of less than two hectares.
- In the year 2017-18, a total area of 39,600,000 hectares of land in India was under cultivation for different spices. India exported $2.6 billion worth of spices to different global markets during the same year, a growth of 6% from the preceding year.
- Though the production of spices is increasing across the country, the productivity of spices is decreasing in many states except a few states namely Madhya Pradesh, Telangana and West Bengal.

The need for developing FSA certified and Organically certified cultivation is becoming more and more important in India.

- Graph in Figure 1 shows the productivity of spices across different states in India. Decreased productivity is due to changing climatic conditions and increased occurrences of weather extremes (prolonged dry spells and flooding due to high intensity short duration rainfall), increased pest and disease incidences etc.

Figure 1: *Graph showing state wise Spices productivity in India*



Source: Spices Board of India

- Thus, there is a need to develop sustainable spices supply to ensure crop productivity by creating awareness among farmers for developing sustainable agriculture practices.
- Thus, the need for developing FSA certified and Organically certified cultivation is becoming more important in India. Spices are primarily meant for export to western markets, where there is increased consumer demand for ecologically certified products, but this market segment is also growing in India itself at a yearly rate of 25-30%.

Overview of Cumin Cultivation

India is one of the major producers and consumers of cumin in the world.

- Cumin (Cuminum cyminum L) is an annual herb and the earliest known minor spices used by humans.
- Cumin seeds are extensively used in ayurvedic medicines prescribed for stomach pain and dyspepsia.
- Cumin is believed to be native to Mediterranean region, mainly cultivated in India, Egypt, Libya, Iran, Pakistan, and many more countries.
- India is one of the major producers and consumers of cumin in the world.
- Almost 80% of the crop cultivated is consumed in India itself. The crop is exclusively cultivated in Rajasthan and Gujarat and both the states together contribute more than 95% of total country's cumin production with Gujarat contributing around 85% of total production.

Image representing Rajasthan and Gujarat respectively as major producers of cumin.

Dry seeds of Cumin

Disclaimer: The geographical map used is for informational purposes only and does not constitute recognition of international boundaries or regions; GIZ makes no claims concerning the validity, accuracy or completeness of the maps nor assumes any liability resulting from the use of the information therein.

Challenges in Cumin Cultivation

Currently, the spice production system faces numerous challenges

- Insufficient legal protection during sale of crop
- Rejection of Export Materials
- Poor Product Quality
- Competition with other spices growing countries
- Insufficient quantities of Good Quality Cumin (Safe to Consume spices)
- Low Productivity
- Insufficient Mechanization of Spice Production and Processing
- Lack of awareness regarding consumer demands and market requirement
- Lack of awareness among farmers about recent innovations in production and post-collect tasks.

Overview of Cumin Industry

The Indian spices industry was expected to grow by USD 20 billion by 2022. Marked spices and spice blends are the focus areas for the growth of the Indian spices sector. With the vision to become one of the top producers of spices, the following initiatives were taken by the Indian government:

Defining specific Indian market centres for each spice.

- AEP is the farmers' centric approach, which focuses on agriculture export promotion, promotion of indigenous and organic agri-produce.
- Organising and participating in various trade fairs, exhibitions to support and increase the potential of Indian farming at national and international level.
- Defining specific Indian market centres for different spices.
- Organising e-Auction Centres for various spices. The most popular one is the e-Auction Centres of Cardamom, which could be replicated for Cumin.

Apart from the above initiatives, various other opportunities are:

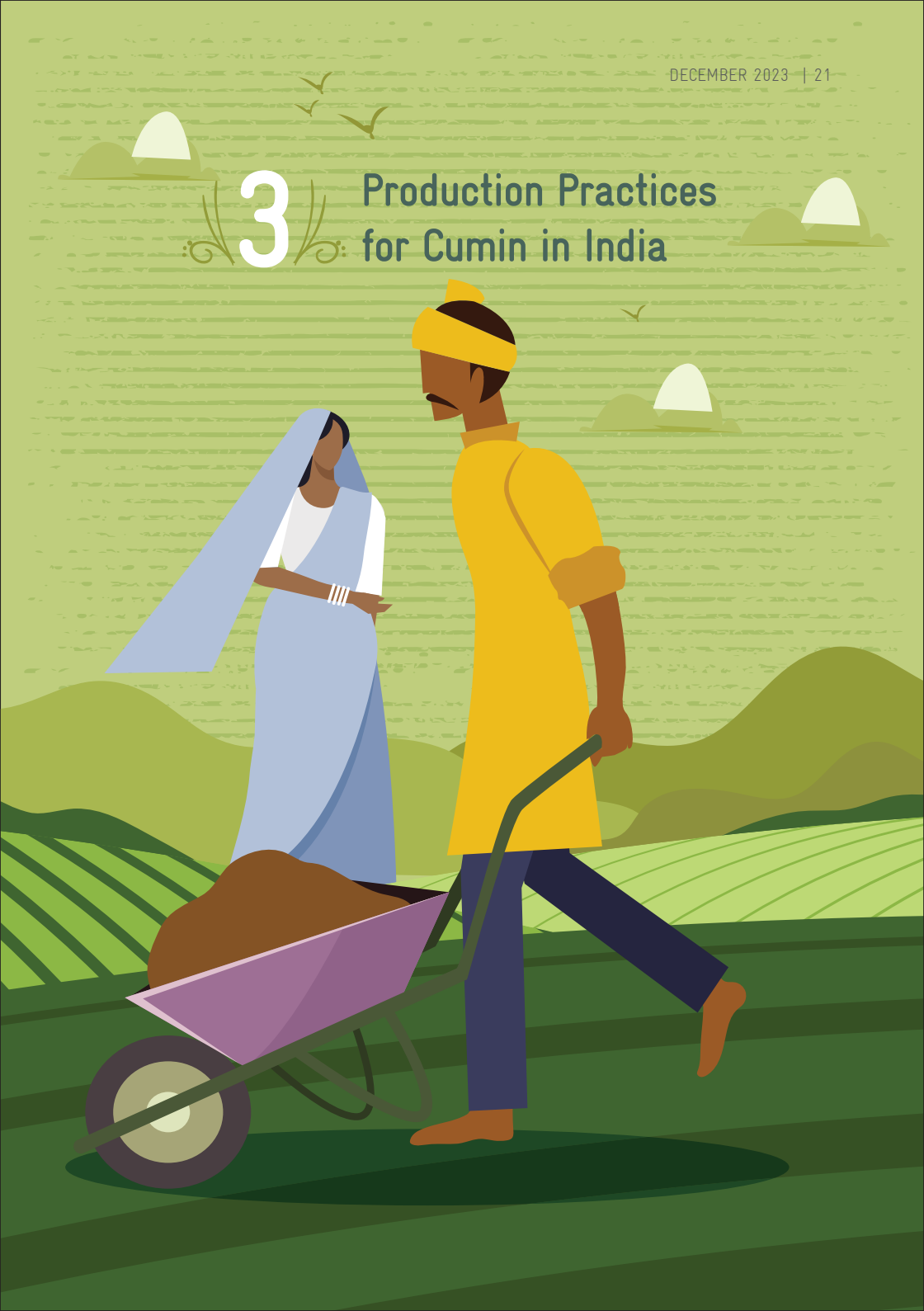
Aggressive implementation of GAPs to produce good quality, food safety centric produce at the farm gate.

- Creating awareness on production technologies for
  - Ensuring sustainability of agro-ecosystems.
  - Improving the quality of the produce by implementing GAPs.
  - Ensuring the quality of the produce by certification of agricultural products.
  - Harmonisation of global standards on biosafety
  - Ensuring sustainability of supplies.
  - Quality establishment through various intervention such as certification and testing schemes.

- Aggressive implementation of GAPs to produce good quality, food safety centric produce at the farm gate.
- Development of facilities for accredited analytical abs to ensure food safety, pesticide residues and development of MRLs.

The Indian government is advancing spice exports through different activities, for example, setting up spice parks. Spice parks offer normal handling offices to the spice producers and exporters.

3 Production Practices for Cumin in India



Production Practices for Cumin in India

India is one of the largest producers, consumers and exporters of cumin. Cumin *(Cuminum cyminum L.;* Family: *Apiaceae)* known as 'Jeera' or 'Zeera' in Hindi is an important spice used in Indian kitchens for flavouring various food preparations.

CUMIN CROP

- Cumin plants grow up to a height of 30 - 45 cm and produce many branches on stems with long divided deep green leaves.
- The leaves are 5 - 10 cm long, pinnate or bipinnate, thread-like leaflets.
- The flowers are small, white or pink and borne in umbels.
- The fruit is a lateral fusiform or ovoid achene 4 - 5 mm long, containing a single seed.
- The seed is elongated, approx. 6 mm long.
- There are different varieties available on the basis of their seed colour i.e., white, yellowish brown and black.
- Cumin seeds have an aromatic fragrance due to the presence of volatile oil (2.5 - 3.5%).

USES OF CUMIN

- It is an important spice used in Indian kitchens for flavouring various food preparations. It is a major ingredient of mixed spices powder and curry powder mixes.
- The aromatic oil of cumin seeds is used for flavouring curries, liquor, cordials and has great use in perfumery industries.
- The seeds are extensively used in ayurvedic medicines prescribed for stomach pain and dyspepsia.
- The seeds are very useful in digestive disorders like biliousness, morning sickness, indigestion, atonic dyspepsia, diarrhea, malabsorption syndrome and flatulent colic.
- Cumin is valuable in relieving sleeplessness.
- Diluted cumin water is an antiseptic beverage and very useful in common cold and fevers, which is associated with sore throat.

NUTRITIONAL VALUE OF CUMIN

Table 1: *The physio-chemical composition of cumin seeds is given below*

Nutrients	Value
Moisture	6.2%
Protein	17.7%
Fat	23.8%
Carbohydrate	35.5%
Crude fibre	9.1%
Mineral Matters	7.7%
Calcium	0.9%
Phosphorus	0.45%
Iron	0.048%
Sodium	0.16%
Potassium	2.1%
Vitamins	Mg per 100g
Vit B-1	0.75mg
Vit B-2	0.38 mg
Niacin	2.5mg
Vit. C	17.2 mg
Vit. A	175 I.U. /100g
Food energy	460 calories/100

Requirements for Cumin Production

1. CLIMATIC CONDITION

- Cumin is a winter season crop.
- Requires moderately cool and dry climate.
- Average annual rainfall required: 30-270 mm.
- Cloud free sunny environment is conducive to its growth.
- Area should be free from severe frost during flowering.
- It does not prefer humidity during flowering and seed setting stage.
- Cloudy weather during flowering and fruiting stages increases incidences of pests and diseases.

Thrives well between 9°C to 26°C. Germination is adversely affected at temperatures above 30°C and below 10°C.

2. SOIL CONDITION

- Cumin can be cultivated in all most all types of soils but well drained coarse loamy or loamy textured soil suits well because standing water and excessive moisture is very harmful to the crop.
- Fertile soils containing good organic matter gives higher yield and quality of the produce.
- pH range 7.0 - 8.0 are most suitable.
- Sites where cumin crop has not been cultivated for the past 3 years should be selected.

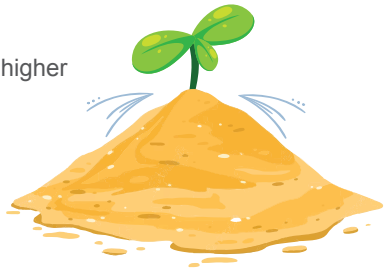


Image represent soil conditioning

3. VARIETIES OF CUMIN

- There are many cumin varieties suitable for different agro-climate regions.
- Variety selection depends primarily on its adaptation to the soil and climatic conditions, preferably with resistance/tolerance to pests and diseases prevailing in that region.
- Endemic varieties need to be encouraged to conserve agro-biodiversity and local varieties that are fast disappearing.

Some of the popular varieties found in Rajasthan are given below:

S. No	Name of Cumin variety	Duration (days)	Desirable yield (q/ha)	Specific characteristics
1	RZ-19	120-140	5 to 6	Plants are erect in growth, bear pink flowers and bold pubescent grains
2	RZ-209	120-130	6.5	Tolerant to wilt and blight diseases
3	RZ-223	120-130	6	The seeds yield an oil content of 3.23% also tolerant to wilt disease
4	RZ-341	120-130	6	Volatile oil content is high
5	RZ-345	120-130		Moderate resistance to wilt, blight and powdery mildew
6	Ac-01-167	120-140	5.15	Resistant to wilt

4. CROPPING SYSTEMS

- Cumin is not recommended for growing as mixed or intercrop.
- But crop rotation is essential for managing certain diseases like wilt and also maintaining soil fertility.
- Some of the suggested cropping systems for cumin growing areas are:

- Growing of more water requiring crops like:


Wheat

Castor

Mustard

Isabgul

Lucerne

near cumin field are favourable to blight disease and therefore, growing of such crop in the vicinity of cumin field should be avoided.

- Growing of


Groundnut

Mustard

near the cumin field should be avoided as these are allergen crops.

5. LAND PREPARATION

- The land should be well prepared for better germination of seeds and growth of plants.
- A total of 3 - 4 ploughings are required to bring the soil to a fine tilth.
- At the time of sowing there should be good moisture in the soil for better germination of seed.

Seed Selection

- Select indigenous seeds that are resistant to pests and diseases.
- Select healthy and weed free seeds.
- It is advisable to select healthy seeds during harvesting and store them properly for next season's sowing.

Seed Treatment

- Seed treatment is essential for better germination and growth of the crop.
- For better and rapid germination, seeds should be soaked in water for eight hours and then surface dried under shade.
- The crop takes 10 - 12 days for germination and therefore two light irrigations are recommended for good germination.
- Water soaked seeds should be kept in a moist condition for six days for sprouting, thus, saving cost of one irrigation. These pre-sprouted seeds provide good germination within six days and require irrigation immediately after sowing.

- Soaking seeds in cow urine and application of biofertilisers gives better results for germination and growth of cumin.
- Seed treatment with *Trichoderma* at 2-3 g/kg of seed or Bavistin 2-2.5 g/kg of seed should be done to avoid incidence of seed-borne diseases.
- Seeds should be inoculated with 10 g/kg of Azotobactor and 10 g/kg of PSB for better germination and growth of the crop.
- Treat the seeds with PGBR bioformulation i.e. FK 14 *(Pseudomonas putida)* + FL 18 *(Microbacterium paraoxidans)* for better germination, growth and yield.

Sowing

Sowing Season:

The time of sowing is an important agro-technique involving no cost but decides the level, production and incidences of disease and pests to a greater extent.

The proper time for sowing is from mid-November to first week of December. However, higher yield can be obtained by sowing around 15 November. But it depends upon favorable day and night temp.

- **Seed Rate:** 10-12 kg per hectare.
  Thinning activity should be carried out during initial hoeing and weeding to destroy the excess plants.

Sowing Methods:

- **Broadcasting:** After broadcasting, the seeds should be covered lightly by soil with help of iron teeth rakes.
- **Line sowing by seed drill:** This method is better than broadcasting for intercultural operations. It promotes better growth and development of the crop and lowers the incidences of pests and diseases.

- **Spacing for line sowing:**
  - Row spacing: 20 cm
  - Plant spacing: 10 cm

The sowing depth for cumin crops should be between 1-1.3 cm and should not exceed 1.5 cm as it may affect the germination of seeds adversely. Gap filling of plants to compensate mortality losses should be carried out within a reasonable time frame after the sowing date.

6. NUTRIENT MANAGEMENT

- Based on the soil fertility analysis and crop requirement, nutrient dosage is recommended. Organic manures are preferred. However, it should be supplemented with mineral nutrition from inorganic sources.
- Application of chemical fertilisers must be based on soil test results which will reduce excessive use of chemical fertilisers and can reduce the cost of cultivation.
- Specialised nutritional application for distinct needs vis., root production or enhancement of leaf biomass needs to be taken up as per the requirement of the crop.
- Apply FYM 10t/ha or compost 5 t/ha at the time of land preparation.
- Apply NPK at 20:20:15 kg/ha (20 kg of N in two equal split doses at 30 at 60 DAS).
- Trichoderma as soil application (2.5 kg/ha) and neem cake as soil application (150 kg/ha) are advisable for better germination and plant growth and establishment. It also reduces the chances of soil borne diseases.
- Following crop rotation with legumes like black gram/green gram, cluster bean/green manuring with *Sesbania aculeata,* composting and application of biofertilisers can also enhance soil quality.
- Using soil amendments like castor or mustard cake, poultry manure at 2.5 t/ha before sowing for control of wilt.

Farm Yard Manure

Nitrogen, Phosphorus and potassium Fertiliser


Neem Cake


Green Gram


Cluster Bean


Sesbania aculeata


Castor Cake


Mustard Cake

Poultry Manure

- Cultivation of green manuring crops before sowing season and incorporation in the soil reduces nitrogen requirement of the crop and improves organic carbon and nitrogen in the soil.
- Use of bioformulations like jeevamrut, amritpani will enhance soil microbial activity and will reduce the chemical fertilisers' requirement.

Fertilisers

- For better yield, the soil should be ploughed thoroughly by mixing 4 tons of FYM (Farm yard manure) per acre or compost of 2 tons per acre.
- FYM should be mixed in the soil at the time of land preparation and 15 kg nitrogen and phosphorus should be applied as a basal dose.
- Another 15 kg nitrogen should be applied as a topdressing one month after germination of seeds.

Impact of Manure

- Increasing the amount of cattle manure from 12.5 - 25 m/fed., will result in significant increase in the plant height, number of branches/plants, number of umbels/plants, fruits dry weight (g)/plant and kg/fed in both seasons.
- Significant increase in the yield of fruit was recorded and reported by raising cattle manure.
- Organic manure includes farmyard manure, compost, green manure, and vermicompost.
- Green manure is the practice of growing and incorporating the crops into the soil. Leguminous plants that have nitrogen-fixing root nodule bacteria are grown as intercrops in mulberry fields and after their yield is harvested, are mulched and used as green manures. It is a cheap and effective method that increases soil fertility as it can supplement farmyard and other organic manures and is more cost effective. Green manures add nitrogen and organic matter to the soil for improving crop productivity. They also improve soil aeration and drainage conditions. Both leguminous and non-leguminous plants are grown for making green manure.

7. INTERCULTURAL OPERATIONS

Weeding

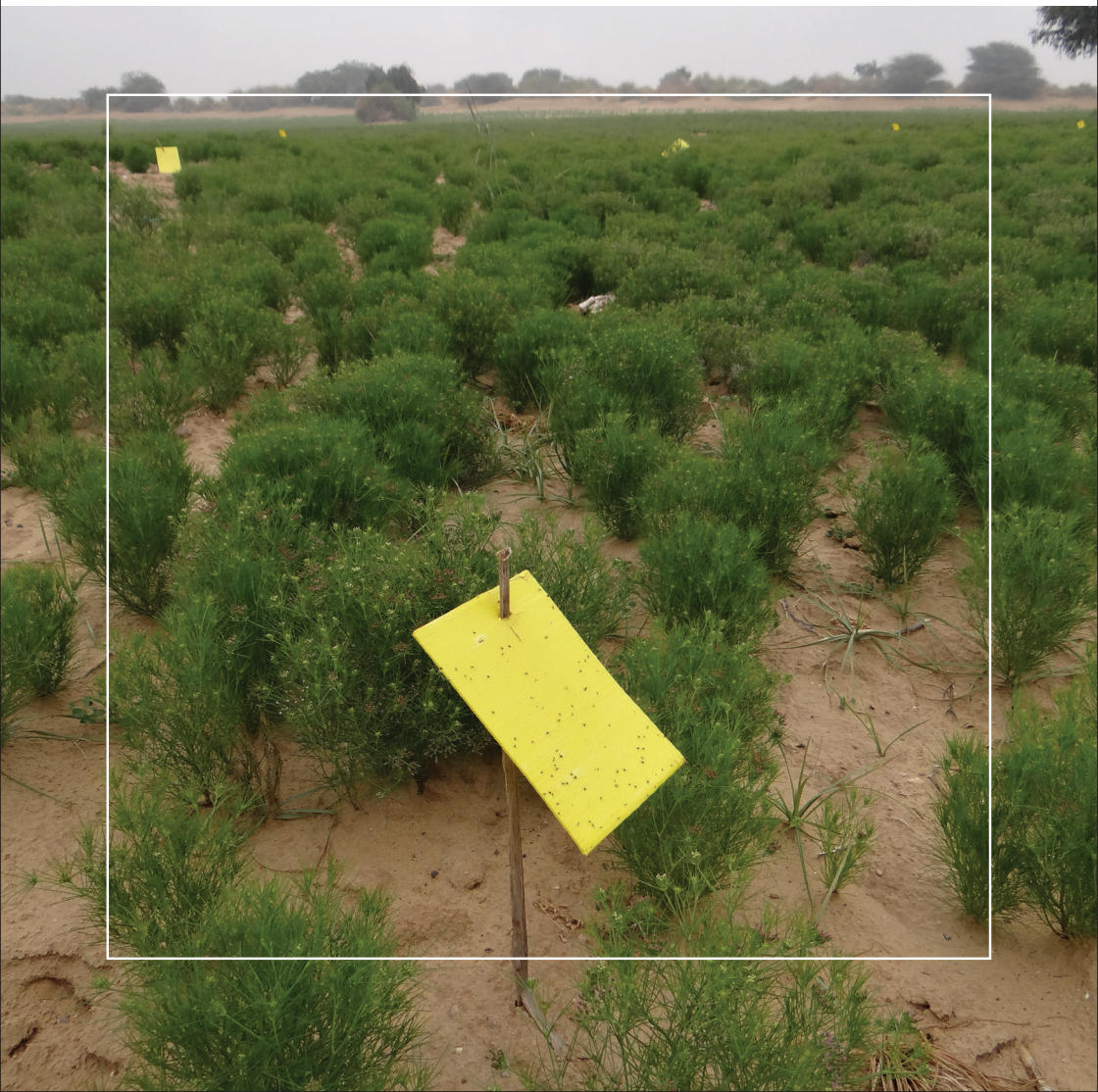
- Cumin crop is severely affected with by competition at all stages of crop growth because of slow growth and short stature of the crop.
- Initial period of weed competition in cumin was between 15-30 days after sowing, therefore this is the most optimum time for hand weeding.
- First hand weeding should be done when plants are 5 cm tall and second, just before flowering for proper growth of the crop.
- In rainfed crop, one or two weeding and hoeing should be done so that the moisture and nutrients available in the soil can be efficiently utilised by the crop.
- In irrigated cumin, 2-3 weeding and hoeing operations are necessary to keep the crop free of weeds.
- Interculture operations become easy if done by line sowing by seed dill.

8. IRRIGATION

Crop water requirement depends upon the variety of the crop, climatic condition, growth stage of the crop.

- Irrigation should be done according to crop water requirements.
- Recommended number of irrigations are 4 - 6 for cumin crops.
- Micro irrigation techniques will save water significantly and enhance water usage efficiency.
- Generally, farmers use sprinkler irrigation for cumin.
- Light irrigation should be given immediately after sowing, followed by irrigation after 8 - 10 days. Germination will start only after second irrigation.
- The first irrigation should not be heavy, otherwise it may result in the uneven distribution of seeds.
- Thereafter, the crop should be irrigated at intervals of 20 - 30 days; depending on the weather conditions and soil type.
- The last irrigation at the time of grain formation should be slightly heavy which will supplement moisture requirement during the crop ripening stage.
- Irrigation during the crop maturity stage should be avoided, as it is likely to affect the seed quality adversely.
- Five irrigations i.e. first at sowing and 10, 30, 55 and 80 days after sowing gives higher yield.
- Heavy irrigation at flower initiation should be avoided to prevent the attack of the most grave disease e.g blight disease.

Subsequent irrigations should be given depending upon the soil type and climatic conditions. Last heavy irrigation should be given at the time of seed formation. Better to avoid irrigation at the time of seed filing it is since it increases the incidence of blight, powdery mildew and aphid infestation.



9. PEST AND DISEASE MANAGEMENT

Pest Management

Aphid

- Occurs generally from December-March.
- It starts at vegetative growth stage and peaks from flowering to seed formation stages.
- It affects flowering and reduces seed formation in cumin, reducing the yield.
- It starts at vegetative growth stage and peaks at flowering to seed formation stages.
- Late sown crop is more susceptible.
- Occurs generally from December-March.

Damage Symptoms:

Aphids damage plants by puncturing them and sucking their juices. Affects the young and soft parts of plants, such as new leaves and shoots.

- It affects the young and soft parts of plants, such as new leaves and shoots.
- Severe infestation can cause shoots to wilt and dry out.
- Aphids secrete a sugary liquid that stimulates black sooty mold growth. It can cover the surface of leaves which affects the way they absorb sunlight.
- Spreads viral diseases.
- Aphids damage plants by puncturing them and sucking their juices.

Management:

- Follow all cultural and mechanical control measures in integrated pest management (IPM).
- Spray the pressurised water on the crop.
- Yellow colour attracts the winged aphids and can be used in trapping the pest. A number of materials like yellow polyethylene (light reflection at a wavelength 562 mm) sheets are very effective for the control.
- Higher application of nitrogenous fertilisers causes higher vegetative growth and thus, heavy population build up to the crop.

- Early spraying of neem seed kernel extract (NSKE) at 5% or neem oil at 2% effectively checks the population growth.
- Planting varieties resistant to aphids can effectively avoid the incidence. Varieties RS-1 and RZ-209 are less susceptible to aphids, whereas, UC-220, UC-218, UC-198, UC-199 and UC-208 shows moderate susceptibility.
- Apply fish oil rosin soap or NSKE (3%), neem oil (2%) or tobacco decoction (0.05%).

Natural enemies of aphids:

- *Parasitoids: Lysiphlebus sp, Diaeretiella sp, Aphelinus sp, Aphidius colemani.*
- Predators: Ladybird beetle, lacewing, spiders, hover fly etc.

Thrips

Infestation of thrips starts at early vegetative growth of crop and is found to prolong up to flowering stages.

Damage symptoms:

Direct damage:

- Thrips damages the undersides of leaves by sucking their juices.
- They damage young and soft parts of plants such as new leaves and shoots.
- It sucks the leaves of plant causes yellowing and drying of leaves.
- As a result, leaves curl downwards and change to a blackish- silver colour.
- Severe infestation causes young leaves to wilt and dry out.

Indirect damage:

- Thrips can carry and spread viral diseases.
- It damages the undersides of leaves by sucking their juices.
- It can damage young and soft parts of plants such as new leaves and shoots.

Spraying of neem seed kernel extract (5%) or neem oil (2%) control pest effectively.

Management:

- Follow all cultural and mechanical practices.
- Blue Sticky traps are very effective in controlling thrips.
- Fish oil insecticidal soap (Na) 2.5% + tobacco (if applicable) extract 2.5% effectively reduces the thrips infestation.
- *Verticelium lacunae* is useful in controlling thrips.

Natural enemies of thrips:

- Parasitiod: *Ceranisus menes*
- Predators: Predatory thrips, minute pirate bug, ladybird beetle, lacewing, mirid bug, hover fly etc.

Cutworm

Persistent dry weather with less or no rainfall, reduced humidity and 16-23°C temperatures favour the development of cutworms.

Damage symptoms:

- Both adults and caterpillars become active at night.
- During the day-time caterpillars hide in cracks and crevices in the soil.
- They attack young plants by severing their stems, pulling all parts of the plant into the ground and devouring them.
- Plants with severed stems have difficulty growing again.
- This pest can cause serious damage; particularly when crops are at 25-35 days after planting.

Management:

Follow all the common cultural, mechanical and biological practices.

Cultural control:

- Deep summer ploughing of fields during summer months in the plains and during autumn in the hills.

- Attracting cutworm larvae using rice bran: heaps of rice bran should be placed in several places in the late afternoon. Larvae can be removed from the rice bran on the next day and destroyed.
- Flood field prior to planting: where/whenever possible farmers can consider temporarily flooding fields, particularly on severely infested fields.

Natural enemies of cutworm:

- Parasitoids: *Trichogramma spp., Tetrastichus sp, Telenomus sp, Bracon sp, Campoletis sp Chelonus sp, Ichneumon sp, Carcelia sp* etc.
- Predators: Lacewing, Ladybird Beetle, Spider, Red Ant, Dragonfly, Robber Fly, Reduviid Bug, Praying Mantis, King Crow Etc.

Tabocco Caterpillar

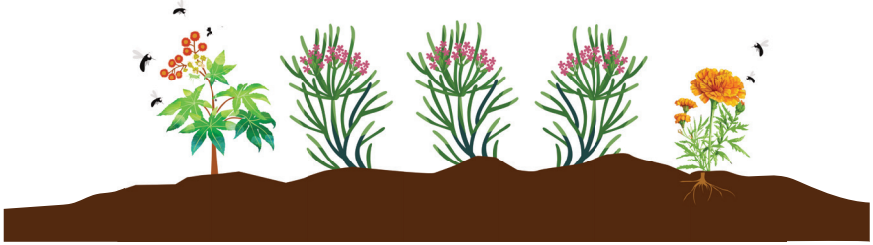
- This pest breeds throughout the year.
- Moth is medium-sized and stout bodied with forewings pale grey to dark brown in colour having wavy white crisscross markings.
- Moths are active at night.

Damage Symptoms:

- In early stages, the caterpillars scrape the chlorophyll content of leaf lamina giving it a papery white appearance.
- Irregular holes on leaves initially and later skeletonisation leaving only veins and petioles.
- Heavy defoliation.

Management:

- Cultivate trap crops like Cater as a border crop.
- Spray Dashparni ark: 200 litre per acre.



Root-knot Nematode

Damage symptoms:

Infested plants exhibit stunting, reduced leaf size, yellowing of foliage.

Management:

- Follow all the cultural and mechanical controls in integrated pest management (IPM) practices.
- Apply organic amendment i.e. mustard, castor or neem cake 8-10 qts/acre.
- Use of *Metarhizin anisophilae.*
- Use of *Pseudomonas fluroscence.*

Deep summer ploughing is very useful for controlling Soil borne diseases.

DISEASE MANAGEMENT

Every produce needs to be taken care of and critically observed. For observing the health of the plant, it is necessary to understand what kind of disease may affect it. Let's discuss the diseases that may occur in cumin.

Wilt

- The disease occurs at all stages of crop.
- The disease is caused by *Fusarium oxysporum* f.sp. cumini.
- The pathogen is seed borne as well as soil borne associated with diseased plant debris and infected soil with fungus.
- Generally, it appears in patches in the field when the crop is about one month old.
- Infected plants show peculiar symptoms of dropping of tips and leaves, leading to mortality of the entire plant.

Damage symptoms:

- Plants usually produce small, thin, shrivelled seeds.
- Wilting symptoms at seedling and later stage of plant growth.
- Brownish discolouration of vascular bundles is seen when the stem is cut longitudinal.

- After the plant dies the fungus invades all tissues, sporulates, and continues to infect neighbouring plants.
- It spreads short distances by irrigation water, rains splash, wind, and through inter- cultural operations.
- Efficient control of this disease is not possible by the use of chemicals.

Management:

Cultural control :

- Collect and destroy disease infected plants.
- Cumin cultivars such as RZ-223 and GC-4 are tolerant to *Fusarium* wilt.
- Use of healthy; disease-free seeds.
- Crop rotation with non-host crop like mustard, pearl millet reduced disease incidence.

Mustard

Pearl Millet

Summer ploughing, sowing time and crop rotation of three years are important parameter.

- Application of mustard cake and groundnut cake was found to reduce the disease.

Mustard Cake

Groundnut Cake

- Application of castor cake and poultry manure before sowing reduces wilt.

Castor Cake

Poultry Manure

- Soil application of vermicompost 3.2 t/ha + Soil application of *Trichoderma viride* at 10 kg/ha OR
- Soil solarisation + soil application of *Trichoderma* + FYM (5 t/ha) OR
- Summer ploughing + N inputs + residues of pearl millet+ oil cakes of mustard and castor (1%) also reduces the wilt.
- Residues of cruciferous plants + mustard residues or oil cake during hot summers and providing one irrigation during rainy season (Mawar and Lodha 2002).

Biological control:

- Seed dressing with *Trichoderma harzianum* T2 isolate, lowered disease incidence by 65.4%.
- *T. aureoviride* and *T. harzianum* as seed plus soil application.
- *Trichoderma harzianum* grown on sorghum grains and applied in soil reduces wilt incidences.

Powdery Mildew

- This disease may cause complete failure of the crop.
- Powdery mildew of cumin is caused by *Erysiphe polygoni.*
- Infection of this disease on cumin reduces the yield as well as economic value of the crop.
- Weather conditions that encourage powdery mildew are cool high humid weather (20-25° C) or cloudy weather and high relative humidity (RH) > 80%.

Disease Symptoms:

- Occurs mostly in cloudy weather; during February/March at flowering stage.
- Powdery growth on cumin develops first on leaves which later can cover all stems and branches including flowers.
- The primary infection of the disease is through soil as well as seed and secondary infection takes place by the dispersal of conidia through rain splashes and wind.
- In severe cases, seed development may not take place.

Management:

- Powdery mildew disease in cumin is difficult to control, hence prevention is the best cure for inhibition of mycelium growth.
- Follow all the cultural management practices described in IPM.
- Crop spacing plays an important role in disease incidence. Crop sown by line sowing is less susceptible than crops sown by broadcasting.
- Extracts of garlic clove, neem leaves and onion bulb performed better for the spore germination inhibition of E. polygoni, the powdery mildew pathogen (Pipliwal, 2013).
- *Verticillium lecanii* has been described as a mycoparasite of powdery mildew and it has been developed as a biocontrol agent.

Alternaria Blight

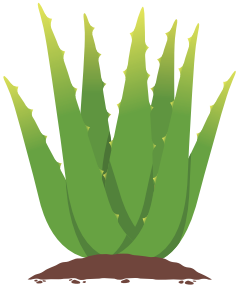
- Cumin blight is the second most important disease which caused by Alternaria burnsii and together with wilt, could be the most destructive.
- It is a seed borne disease.

Damage symptoms:

- Dark brown spots on leaves as well as stems, whereby the stem tips bend downwards.
- Disease appears during warm humid weather as an epidemic at flowering stage so the seed cannot mature to a full size.
- It also occurs in cloudy weather after flowering.
- Seeds become shrivelled and are easily blown away during winnowing.
- Early sown crop faces high intensity of disease and produces unmarketable seed.
- Disease becomes widespread in wet weather with temperature ranging from 20-32° C accompanied by high humidity and cloudy weather.

Management:

- *T. viride, T. hamatum* and *A. awamori* inhibit the growth of blight.
- For radial growth and spore germination inhibition of alternaria, garlic clove and ginger rhizome extract have proved to be the best source of plant origin (5% and 10% extract of garlic cloves and ginger rhizomes).



- Plant extracts of aloe vera, *Calotropis procera, eucalyptus golobulus, Azardiratcha indica* leaves and *A. indica* seed kernel are very effective in the growth and spore germination of *A. burnsii.*
- Thus, neem extract (5% NSKE) and dashparni ark are also effective in controlling the disease.

Damping Off

- This soil borne disease is primarily spread by pathogens via soil, water and secondary spread takes place via rain splash and wind.
- High humidity, high soil moisture, high dose of nitrogenous fertilisers, cloudiness and low temperatures below 24° C for few days are ideal for infection and development of the disease.
- Crowded seedlings, dampness due to high rainfall ill-drained soil conditions and excess of soil solutes hamper plant growth and increase the pathogenic damping-off.

Damage symptoms:

- It occurs in two stages i.e., the pre-emergence and the post-emergence phase.
- In the first stage, seeds rot and the seedlings are killed just before they reach the soil surface.
- Once the seedling emerges out of soil line, a soft water-soaked lesion appears near the collar region causes constriction and results in toppling over of the seedlings.
- The young radical and the plumule are killed. There is complete rotting of the seedlings.

Management:

- Collect and destroy crop debris.
- Judicious use of fertilisers.
- Avoid water logging and any stress to the crop as much as possible.

10. INTEGRATED PEST AND DISEASE MANAGEMENT TECHNIQUES

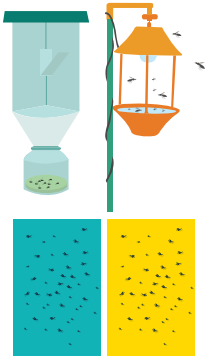
It is a dynamic process that uses an ecological system approach and encourages the user or producer to consider and use the full range of best pest control options available; given the economic, environment and social considerations. It promotes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.

Cultural Practices:

- Deep ploughing is to be done on bright sunny days during the months of May and June. The field should be kept exposed to sunlight at least for 2-3 weeks.
- Adopt crop rotation.
- Grow only recommended varieties.
- Sow early in the season.
- Sow the seed in rows at optimum depths under proper moisture conditions for better establishment.
- Maintain optimum and healthy crop stand which would be capable of competing with weeds at a critical stage of crop weed competition.
- Use NPK fertilisers as per the soil test recommendation.
- Use micronutrient mixture after sowing based on test recommendations.
- Collect and destroy crop debris.
- Judicious use of fertilisers.
- Provide irrigation at critical stages of the crop.
- Avoid water logging.
- Avoid any stress to the crop as much as possible.

Mechanical Practices:

- Collect and destroy disease-infected and insect-infested plant parts.
- Collect and destroy eggs and early-stage larvae.
- Handpick the older larvae during early stages of the crop.
- Handpick the caterpillars and the cocoons which are found on stem and destroy them in kerosene mixed water.
- Use yellow sticky traps: 4-5 traps/acre.
- Use light trap: 1/acre and operate between 6 pm and 10 pm
- Install pheromone traps: 4-5/acre for monitoring adult moths activity (replace the lures with fresh lures after every 2-3 weeks).



- Erect bird perches: 20/acre for encouraging predatory birds such as King Crow, Common Mynah etc.
- Set up bonfire during evening hours at 7 - 8 pm.

Biological controls:

- Always treat the seeds with approved biopesticides/ chemicals products for the control of seed borne diseases/pests.
- Release parasitoids only after noticing adult moth catches in the pheromone trap or as pheromone trap or as per field observation.
- In case of pests which are active during night such as spodoptera, spray recommended biopesticides/chemicals at the time of their appearance in the night.

11. HARVEST

- Generally, cumin crop takes about 110 - 115 days to reach maturity.
- Crop becomes ready to harvest when plants turn yellowish-brown.
- Harvesting should be done early in the morning by cutting/ uprooting the whole plant.
- Harvested crops should be dried in the threshing yard to separate the seeds.
- Seeds should be cleaned by winnowing.

12. POST-HARVEST PROCESSING

For better post-harvest practices, a few factors need to be considered:

- Threshing floor should be neat and clean.
- Threshing should be done on a concrete floor.
- Using innovative dryers, which quicken the process of drying.
- Processing and drying should be done on the concrete floor.
- Store at an appropriate moisture level.
- Store in a cool and dry place.

Threshing

- Threshing should be done by threshers that have not been used previously for mustard, as it increases the chances of allergens i.e., mustard in cumin seeds.
- Use threshers only after cleaning them properly.
- The seeds are further dried to 10% moisture content, either by placing on mats or trays in the sun or by using a drier if the conditions are too humid.
- The dried seeds are winnowed using a traditional winnowing basket to remove the dirt, dust, leaves and twigs.

Packaging

- Cumin seeds can be packaged in polythene bags of various sizes according to the market demand.
- The bags should be sealed to prevent moisture from entering. Sealing machines can be used for this purpose.
- Attractive labels, with all relevant product and legal information like the name of the product, brand name (if appropriate), details of the manufacturer, (name and address), date of manufacture, expiry date, weight of the contents, added ingredients (if relevant) plus any other information that the country of origin and of import may require (a barcode, producer code and packer code) should be added.

- Hermetic bags can be used to pack the cumin seeds. These bags can store cumin seeds without applying chemical fumigants.

Storage

- Dried cumin seeds must be stored in moisture-proof containers away from direct sunlight.
- The stored seeds should be inspected regularly for signs of spoilage or moisture. If they have absorbed moisture, they should be re-dried to a moisture content of 10%.
- The storage room should be clean, dry, cool and free from pests.
- Strong smelling foods, detergents and paints should not be stored in the same room as they will spoil the delicate aroma and flavour of the cumin.
- Hermetic bags are very useful to store the seeds without applying chemicals and also maintain the vitality of the seeds.
- Cumin can be stored for more than a year without the risk of moisture ingress.

Hermetic bags

- It stops insect infestation and inhibits the growth of fungal contaminants without affecting the aroma, color and freshness.
- It also preserves the germination rate of stored seeds.
- These bags are portable, gas-tight, moisture-tight and reusable.
- They are 500 times more airtight than normal plastic.
- It protects against mould growth and insect infestation.
- It retains the taste, colour and aroma.
- It preserves quality for longer periods of time for the purpose of storage (up to 1 year).
- It is suitable for storage of organic products.

4 Certification for Farm Sustainability Assessment (FSA)

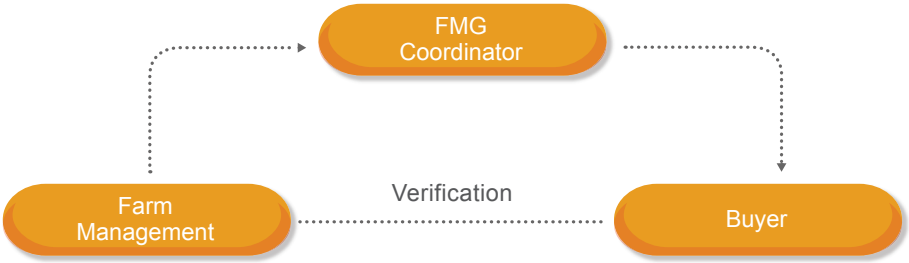
Certification for Farm Sustainability Assessment (FSA)

Farm Sustainability Assessment (FSA) is a food and beverage industry-aligned multi-purpose tool to assess, communicate and improve on-farm sustainability. FSA is designed to improve social, environmental, economic and general farm management practices. It is the tool that gives insight into understanding how to grow crops using sustainable practices. It helps the farmers to include evidence-based farm sustainability to broaden their understanding of cost, efficiency, and yield improvements. Further, it makes growers more aware of the value of sustainable farming in their customer relationships.

There are three key benefits of FSA for farmers:

1. FSA is a great way to assess sustainable agriculture practices and communicate them to customers.
2. Using the tool helps save time and money, by removing the need to complete multiple assessments for multiple customers.
3. Being a user of FSA increases market access, by selling to more companies who use FSA as their sustainable sourcing standard.

FUNCTIONS AND ROLES WITHIN FSA IMPLEMENTATION



A farm may be composed of several physical separate farm fields producing crop(s) in scope of the assessment. A farmer is the person carrying final responsibility for the farm's performance and the SAQ. This may be the farmer-owner or an appointed farm manager.

The FMG is a group of farms that implement the FSA together, optionally including the direct buyer for their crop(s). The FMG needs to fulfil FSA requirements to ensure that it is a coherent, engaged, and transparent group of farms. The FMG is managed by an FMG Coordinator.

The Farm Management Group Coordinator is the organisation that legally represents the Farm Group. It is usually a first level aggregator or processor or a cooperative. The FMG Coordinator typically buys raw agricultural products from farms and is responsible for implementing the FSA in accordance with normative documents. The FMG Coordinator sets up and manages the FSA Management System. The individual responsible for FSA implementation within the FMG Coordinator is referred to as FMG Manager.

Verification Bodies are SAI Platform approved independent organisations, accredited to perform FSA verification audits and issue FSA Letters of Attestation.

FSA MODULES

The FSA is a set of adaptable modules supported by tools and guidance materials. The use of these modules and tools are governed by normative documents to ensure users can demonstrate to auditors that they have used the tools correctly and confidently communicate the results.

The modules contain:

1. Self-Assessment Questionnaire (SAQ).
2. Priority Screening Module (PSM).
3. Continuous Improvement Module (CIM).
4. Outcome Measurement Module.
5. Verification Module.
6. Benchmarking Module.
7. Supply Chain Module.

A buyer is an organisation in the supply chain buying FSA verified material from a standalone farm, an FMG Coordinator or another buyer.

Self-Assessment Questionnaire (SAQ)

FSA based on the Self-Assessment Questionnaire (SAQ), ensures that the FSA is implemented effectively, consistently, and accurately, so that any resulting performance claims are reliable. The FSA is made up of 112 questions; there are three levels of questions with increasing complexity: 'Essential', 'Basic' and 'Advanced'.

- **'Essential'** questions are about decent citizenship (e.g. prohibiting forced or bonded labour) and should be straightforward to comply with for any farmer working towards sustainability.
- **'Basic'** questions identify the fundamental elements of sustainable farming.
- The next step in sustainable farming is captured in the **'Advanced'** questions.

The FSA questions are organizsed by topics (e.g. crop protection), in phases (e.g. assess, plan, store) and by focus areas (i.e. people, plant, profit). Sorting filters on each column allows the user to sort the questions in the way that best suits them.

After the FSA is completed, a performance score is automatically generated. To allow a proper analysis of the scores and to identify the points for improvement, the scores are presented per topic, phase and PPP classification.

There are three levels of performance: bronze, silver and gold, each with a specific threshold:

Bronze:

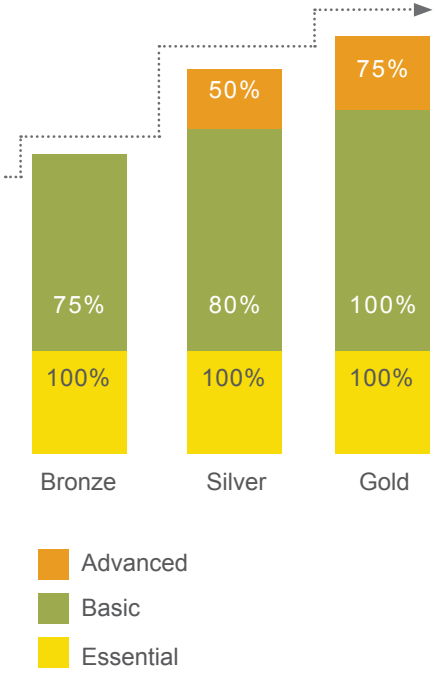
- Bronze Compliance with 100% 'Essential' questions and;
- A minimum of 75% 'Basic' questions.

Silver:

- Compliance with 100% 'Essential' questions;
- 80% 'Basic' questions and;
- A minimum of 50 % 'Advanced' questions.

Gold:

- Compliance with 100% 'Essential' questions;
- 100% 'Basic' questions and;
- A minimum of 75% 'Advanced' questions.



Priority Screening Module

The Priority Screening Module is meant for the Farm Management Group (FMG) Coordinator to perform a high-level screening of social, environmental, and business priorities for the farms in the FMG. This provides the FMG Coordinator with an opportunity to better understand the sustainability context in which the farm operates, in connection to farm characteristics and customer priorities.

Continuous Improvement Module

The Continuous Improvement Module is a set of guidance materials and templates to help the FMG Coordinators develop, implement, and monitor a continuous improvement plan for the FMG. The Continuous Improvement Plan will be subject to the FSA Management System audit in case of independent verification of Farm Management Group Performance and is optional for verification at stand-alone farms.

Outcome Measurement Module

The Outcome Measurement Module provides an overview of tools to help measure environmental and social outcomes of farming. The module provides guidance on linking outcome measurement tools to Continuous Improvement Plans, how to select the right tool for the Farm Management Group and how to use the results in communicating outcomes.

Verification Module

The Verification Module allows farms or FMGs that have implemented the FSA to demonstrate their performance through independent third-party verification. Verification by SAI Platform approved Verification Bodies results in an FSA performance claim at bronze/silver/gold level.

Benchmarking Module

The Benchmarking Module allows agricultural sustainability schemes to be benchmarked against the FSA Self-Assessment Questionnaire and FSA normative documents.

Supply Chain Module

The Supply Chain Module guides businesses that buy agricultural ingredients, or products with such ingredients, in implementing the FSA in their business and with their suppliers.

Step-by-Step FSA Implementation

The process for implementing the FSA is outlined in a step-by-step way to make it easier to understand. In most cases, this will also be the most effective and efficient way to implement the FSA.

Step 1: Get Internal Agreement

FSA Implementation works best if internal management of the FMG Co-ordinator and Farm Managers buy into the 'why' and the 'how' of it. It is important to keep an open mind to adjust your aspirations based on the external conversations you have about them, and the learnings that come through implementing the FSA.

Step 2: Set up the FSA Management System

Having an adequate FSA Management System in place is a key requirement for FSA Implementation, as well as a key verification requirement. This is to ensure the FSA is implemented in accordance with the Implementation Framework as well as to enable the FMG Coordinator or Stand-Alone Farm to take accountability for the results.

The FSA Management System should consist of the following components:

- Farm Management Group.
- Accountability and Administration.
- Volume Accounting System.
- Continuous Improvement Plan and Report/ Accounting period.
- Setting up the Farm Management Group.

  The Farm Management Group (FMG) is a group of farms implementing the FSA in a joint fashion. This is the most efficient way to organise farmer engagement, achieve farm improvements, and perform FSA performance level assessments. By being part of a group, farmers can share expertise and experience, and support each other in making improvements. It is recommended that farms in a group are already naturally grouped because this facilitates a smoother implementation of the FSA.
- Accountability and Administration of FMG Coordinator.

  The FMG Coordinator is the legal entity responsible for implementing the FSA in accordance with the Implementation Framework. This means it is responsible for identifying and engaging the individual farms within the FMG. During an FSA Management System Audit, the FMG Coordinator must be able to show the auditor that it fulfilled its responsibility.

Therefore, the FMG Coordinator needs to demonstrate conformance with the requirements given below:

FMG Coordinator Requirements on Accountability:

- o The FMG Coordinator's top management must document its commitment to implement and maintain the FSA Management System in accordance with the FSA Implementation Framework.
- o The day-to-day implementation of the FSA is managed by an FMG Manager, who is a competent person with a contractual relationship with the FMG Coordinator.
- o The FMG Coordinator must regularly evaluate the implementation of procedures and conformance with the FSA Management System requirements, at least once per year. The findings must be reviewed by the FMG Coordinators' top management.

FMG Coordinator must maintain the sufficient records, including the following information:

- List of farms included in the FMG including contact details per farm.
- Completed Self-Assessment Questionnaires by sampled farms in the FMG.
- FSA Audit Reports and FSA Letters of Attestation per FMG.
- The FMG Coordinator must demonstrate that its Volume Accounting System meets the requirements and record volume accounts at least annually.

The FMG Coordinator must have written procedures and definitions for managing the FSA Management System.

- The FMG Coordinator must demonstrate that its Continuous Improvement Plan meets the requirements and record progress against the plan at least annually.

- **Volume Accounting System**

  The purpose of the Volume Accounting System is to support the generation of accurate and reliable verified FSA claims and to ensure there is no double counting of FSA-verified volume. Following are the terms required to be understood:

  - Mass balance Accounting -

    This is a system in which FSA-verified and nonverified material is mixed physically but kept separate via an administrative trial to ensure there is no overselling of FSA-verified volumes.

  - Quantity Credit Method -

    The FSA requires the use of the quantity credit method for mass balance accounting. A ‘credit’ is a unit of material at a specific verified FSA performance level (i.e. bronze, silver, or gold). The FMG Coordinator must set up and maintain a credit account for each crop at each FSA performance level used as an output declaration. The credit output (volume of material sold at that performance level) must be deducted from the credit account for that material/performance level, up to the limit in, but not exceeding, the credit account (considering conversion factors). The credit account balance cannot be negative.

Step 3: Priority Screening Module

This module is built around the Priority Screening Tool (PST) and the summary report this tool generates. The PST is available as an online application. Once there is clarity on the composition of the Farm Management Group, the FMG Coordinator must fill out the PST. The PST can also be used by a Stand-Alone Farm voluntarily, although not all sections are equally relevant. The PST summary report serves three basic purposes:

- Understanding the sustainability context of the FMG.
- Identifying potential mistakes in the set-up of the FMG.
- Informing the Verification Body about the farm base and farming context.

Step 4: Deploy FSA Self-Assessment Questionnaire

Implementing the FSA at a stand-alone farm simply requires the farmer to complete the SAQ. Since the questions are formulated generically, farmers might find it useful to consult the question level requirements and guidance included in the SAQ. When implementing the FSA with a Farm Management Group (FMG), the FMG Coordinator needs to take an Internal Self-Assessment Sample of farms from the group according to the sampling regime. This must be a random sample to ensure there is no bias in the sample. The FMG Coordinator may also ask a Verification Body or another service provider to take the sample on its behalf. This makes sampling easier for the FMG Coordinator and ensures it is being done correctly.

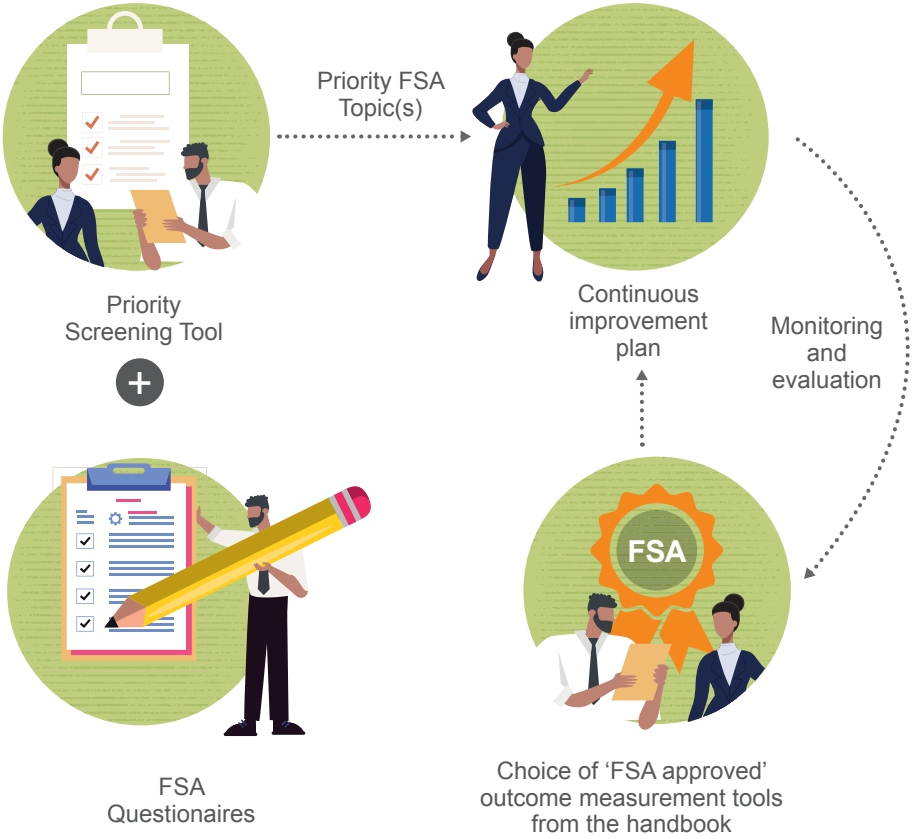
Step 5: Develop Continuous Improvement Plan

This module provides guidance for Farm Sustainability Assessment (FSA) users on how to develop a Continuous Improvement Plan (CIP). The guidance has been created with a focus on the process for Farm Management Groups (FMGs) which need to have a CIP as part of their FSA Management System. The approach can be adapted for Stand-Alone Farms, although the CIP is a voluntary requirement for them. It is generally not required by the FSA to have CIPs at farm level. The process for developing a CIP is designed to be flexible rather than rigid and overly prescriptive. This flexible design allows for multiple pathways for addressing continuous improvement priorities and targets identified as part of the process. Optimising farmer engagement and outreach are key to developing and implementing a Continuous Improvement Plan successfully.

Step 6: Start Outcome Measurement

SAI Platform encourages FMGs to use outcome measurement tools to monitor and support progress on those topics where there are CIPs in place.

Outcome Measurement Pathway



Step 7: FSA Verification Audit

The purpose of the FSA Verification Audit is to validate that the FSA has been implemented correctly, and that the result of the FSA Self-Assessment is accurate and applicable to the Stand-Alone Farm or the entire Farm Management Group (FMG).

A successful FSA Verification Audit results in a Letter of Attestation confirming the performance of the Stand- Alone Farm or FMG. A valid Letter of Attestation is required for making FSA Volume Claims.


1
Implement the FSA
2
Select a verification body
3
Do FSA Pre-Audit
4
Prepare for verification Audit
5
FSA Management System Audit
6
On-Farm Audit(s)
7
Review and agree audit result
8
Receive Letter of Attestation
9
Make FSA Claims
10
Report FMG Composition Annually
After 3Years

How to Complete the Farm Sustainability Assessment

Step 1: General Data

To begin, provide answers to the general questions about the farm. These answers do not affect the performance score, but they help to put the results into context and prevent misinterpretation.

- This section is made up of 15 questions, most of which have open answers.
- Use the guidance notes in Section 4 to learn more about the background of a question.

Step 2: Farm Sustainability Assessment

After the general section, you can start filling in the FSA. FSA is made up of 112 questions which have been separated into tables according to the topic as follows:

Topic	Number of Questions	Codes
Legal Compliance	3	FSA1 - FSA3
Financial Stability	4	FSA4 -FSA7
Farm Management	5	FSA8 -FSA12
Planting	6	FSA13 -FSA18
Soil Management	4	FSA19 -FSA22
Nutrient Management	7	FSA23 -FSA29
Crop Protection	12	FSA30 -FSA41
Agro-chemicals	9	FSA42 - FSA50
Waste Management	2	FSA51 - FSA52
Water Management	10	FSA53 -FSA62
Biodiversity	6	FSA63 - FSA68
Air	2	FSA69 - FSA70
Greenhouse Gas Emissions	2	FSA71 - FSA72
Market Access	4	FSA73 - FSA76

Topic	Number of Questions	Codes
Labor Conditions	22	FSA77 - FSA98
Health and Safety	11	FSA99 - FSA109
Local community	3	FSA110 - FSA112

- Essential' questions are coloured orange.
- 'Basic' questions are coloured red.
- 'Advanced' questions are coloured blue.

Acceptable Responses:

- You can only answer 'yes', 'no' or 'N/A'. If you only partially comply with the question, the answer should be 'no'.
- Not all questions can be considered 'N/A'. The requirements column explains when N/A can be used.

Guidance Notes:

- Use the guidance notes in Section 4 to learn more about the background of a question.

Optional Questions:

- If you do not use irrigation, you do not need to answer the following questions:
  - FSA53 – FSA58
  - FSA62

- If you do not have any employees, you do not need to answer the following questions:
  - FSA77 – FSA 94
  - FSA98
- All applicable questions should be answered once the FSA is answered completely.
- As a final check, go to the top of the document to see if you have answered all questions.

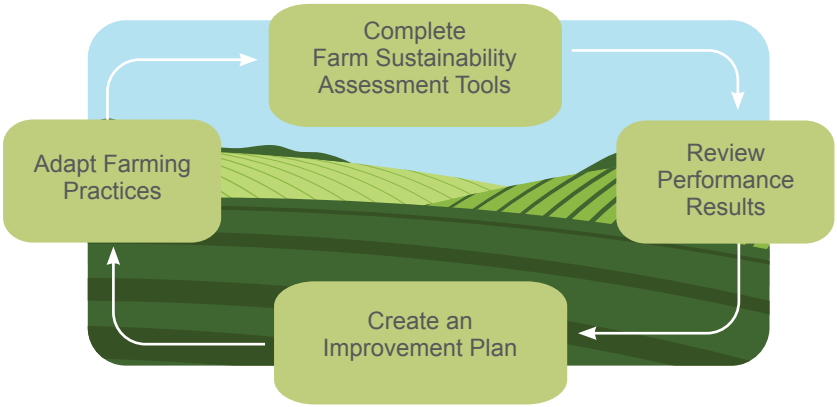
Step 3: How to Calculate Your Performance Score?

Once both the general and the Farm Sustainability Assessment questions have been filled in, this information can then be entered into either the offline/ excel tool or the online calculation by you or another relevant party.

It is the choice of the farmer whether to share the results of Farm Sustainability Assessment with interested parties.

Step 4: Improvement Potential

An improvement plan can be created using the scores per topic i.e. which topics are well covered and which are not by your current farming practices. After you have assessed which farming practices can be changed or new ones can be used, and after these changes are put into place on your farm, you can redo the FSA to see how these changes have improved your overall score.



Summary

Sustainable agriculture in the context of spice production involves practices that ensure the long-term viability of spice cultivation while minimising negative environmental and social impacts. Here are some key principles of sustainable agriculture specifically tailored to spice production:

Biodiversity Conservation: Preserve and promote diverse ecosystems on spice farms to support natural pest control, enhance soil health, soil fertility, and protect local flora and fauna. It will help to prevent soil and water erosion, and improve the overall resilience of the farm by implementing a Biodiversity Action Plan for Cumin farms.

Soil Health Management: Implement practices such as cover cropping, composting, and reduced tillage to maintain soil fertility, structure, and microbial diversity, ensuring the health of the soil by enhancing soil organic carbon for spice cultivation.

Integrated Pest Management (IPM): Adopt IPM strategies to manage pests and diseases in a holistic manner. This includes using biological control agents, crop rotation, trap crop cultivation, use of mechanical traps such as Yellow Sticky traps, Blue Sticky traps, Pheromone traps and targeted pesticide application only when necessary if pest infestation goes beyond Economic Threshold Level (ETL).

Water Efficiency: Employ efficient irrigation techniques such as drip or precision irrigation as per crop water requirements to minimise water usage and reduce water-related environmental impacts.

Agroforestry: Integrate spice cultivation with tree planting to create shade, prevent soil erosion, enhance biodiversity, and improve overall farm resilience.

Seed Saving and Diversity: Encourage the saving and sharing of traditional spice seeds to maintain genetic diversity and resilience within spice crops. Conserving own seed will also reduce the cost of cultivation.

Local and Indigenous Knowledge: Incorporate traditional knowledge and practices of local communities in spice cultivation, respecting their expertise and understanding of the land.

Organic Farming Practices: Opt for organic farming methods to avoid synthetic pesticides and fertilisers, reduce chemical runoff and promote healthier ecosystems.

Capacity Building: Provide training and resources to spice farmers to enhance their knowledge of sustainable agricultural practices and their ability to implement them effectively.

Traceability and Quality Control: Establish traceability systems to ensure the quality and safety of spices from farm to market, enhancing consumer trust and reducing the risk of contamination.

Energy Efficiency: Explore renewable energy sources such as solar power for spice processing and drying, reducing the carbon footprint of spice production.

Waste Reduction and Recycling: Develop methods for reusing and recycling waste materials from spice processing and packaging, minimising environmental impact.

Certification: FSA SAI certification for farmers groups to help them to get better prices.

Production of safe-to-consume spices: Promote the cultivation of sustainable and organic spices, reducing the risk associated with contamination of crops with pesticide residues and ensuring suitable for safe consumption.

Market Linkages: Build industry-wide capabilities around sustainable spice farming by providing buy-back arrangements and market access to the farming communities engaged in the sustainable production of spices.

Reducing the cost of cultivation: All the above-mentioned practices will reduce the cost of cultivation without compromising the yield which ultimately contributes to the enhancement of farmers' income.

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OTHER AVAILABLE RESOURCES ON THE WEBSITE:

- Handbooks on Concept and Methods of Integrated Pest Management in Sustainable Agriculture, Soil Sampling and Soil Testing, Integrated Nutrient Management and Low-Cost Organic Formulations (English, Hindi, Kannada and Malayalam).

- Farmers' Manuals on Sustainable Production Practices for Cardamom (English and Malayalam), Cumin (English and Hindi) and Turmeric (English, Kannada and Tamil).

- Farmers' Diaries on Cumin (Hindi), Turmeric (Tamil), Dill seed and Celery (Hindi).

- Animated Video Series on Practicing Sustainable Agriculture, Sustainable Food production, organic farming and more (English, Hindi, Kannada and Malayalam).

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