Sustainable Production Practices for Turmeric

FARMERS' HANDBOOK | December 2023

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Funding programme
Partners in Transformation

Implemented by
giz

In cooperation with

Published by:
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices:
Bonn and Eschborn, Germany

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This developPPP.de 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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On behalf of the
German Federal Ministry for Economic Cooperation and Development (BMZ)

As at December 2023

FARMERS' HANDBOOK

Sustainable Production Practices for Turmeric

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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 turmeric, 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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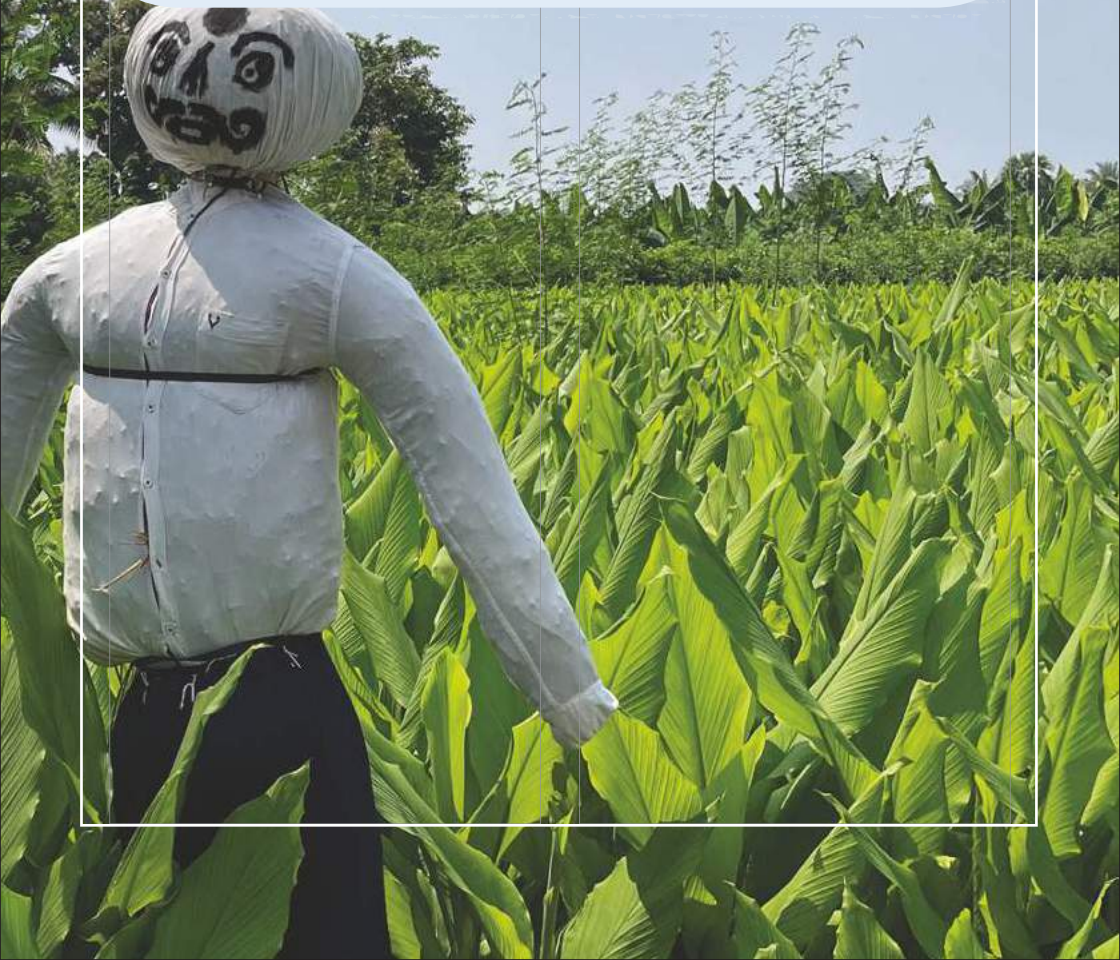


1 Why Sustainable Agriculture Practices

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 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.

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 to 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 ha 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 yield 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 & 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, vermicomposting 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.

- Early identification of pest attacks by installation and monitoring of mechanical traps like light traps, yellow sticky traps, blue sticky traps, pheromone traps etc.

- Use of bio pesticides like Dashparni ark, Neem ark, Amrutpani etc.
- 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 amount 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 for the farmers and also reduce the dependency and cost of cultivation of the crops.

2 Overview of Spice Production in India

Overview of Spice Production in India

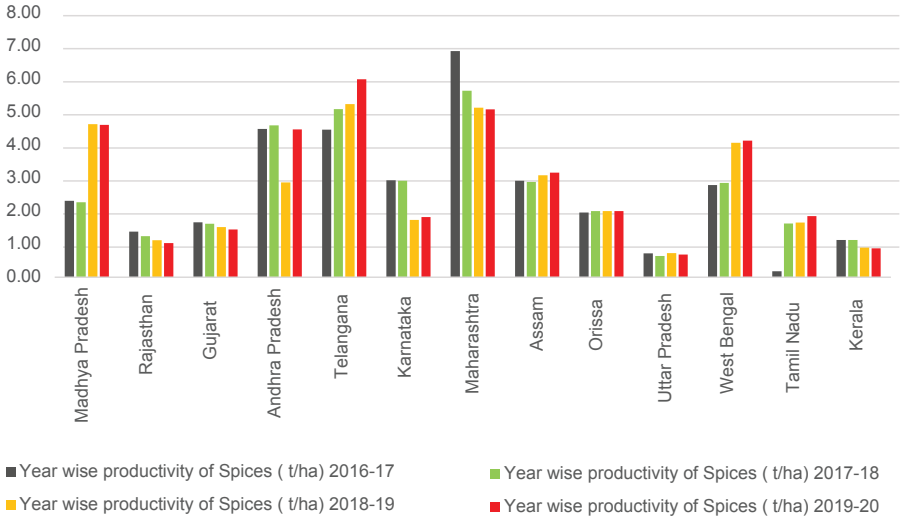
The demand for spices has tremendously increased during the pandemic period due to its medicinal properties and its role in enhancing immunity.

- 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 for 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 or few states, namely Madhya Pradesh, Telangana and West Bengal.

Traditionally, spices in India have been grown in small land holdings, which support the rich culinary culture of 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 an increased consumer demand for ecologically certified products, but this market segment is also growing in India itself at a yearly rate of 25-30%.

3 Turmeric Cultivation Practices

Turmeric Cultivation Practices

Introduction

1. CLIMATE CONDITION:

- Turmeric can grow successfully in a warm and humid climate. It can be grown in diverse tropical conditions from sea level to 1500 m having a temperature range of 20-30°C with a rainfall of 1500 mm or more per annum as a rainfed crop or under irrigated conditions.
- Average annual rainfall in Erode district (Tamil Nadu) is 717 mm, in plains and around 1100 mm in the hills.
- The prevailing agro-climatic condition of Erode is highly suited for turmeric cultivation.

2. SOIL CONDITION:

- Turmeric can be grown under different soil types, but it thrives well on well-drained sandy or clay loam with a pH range of 6.5 - 7.5 which is ideal.
- Soil, rich in organic content gives better yield.
- Incorporation of green manures like sesbania or dhaincha into the soil before sowing turmeric plants helps to improve soil health.
- Proper drainage of soil is very useful for the crop to avoid Rhizome Rot disease in the future.

3. VARIETIES OF TURMERIC:

- Several cultivars are available in the country, known mostly by the name of the locality where they are cultivated.
- Some of the popular varieties are listed below:

Table 1: *Varieties of turmeric*

Variety	Mean yield (fresh) (t/ha)	Crop duration (days)	Dry recovery (%)	Curcumin (%)	Oleoresin (%))	Essential oil (%)
ICAR-Indian Institute of Spices Research, Kozhikode						
Suvarna	17.4	200	20	4.3	13.5	7
Suguna	29.3	190	12	7.3	13.5	6
Sudarsana	28.8	190	12	5.3	15	7
IISR Prabha	37.5	195	19.5	6.5	15	6.5
IISR Prathibha	39.1	188	18.5	6.2	16.2	6.2
Tamil Nadu Agricultural University, Coimbatore						
Co 1	30	285	19.5	3.2	6.7	3.2
BSR 1	30.7	285	20.5	4.2	4	3.7
BSR 2	32.7	245	20	3.8	-	-
High Altitude Research Station, OUAT, Pottangi, Odhisa						
Roma	20.7	250	31	6.1	13.2	4.2
Suroma	20	255	26	6.1	13.1	4.4
Ranga	29	250	24.8	6.3	13.5	4.4
Rasmi	31.3	240	23	6.4	13.4	4.4
Surangi	23.4	180-200	28	4.5-6.5	12.7	4.6
Tirhut College of Agriculture, RAU, Dholi, Bihar						
Rajendra Sonia	42	225	18	8.4	10	5
ICAR Research Complex for NEH Region, Shillong, Meghalaya						
Mega Turmeric 1	23	310	16.4	6.8	-	-

Variety	Mean yield (fresh) (t/ha)	Crop duration (days)	Dry recovery (%)	Curcumin (%)	Oleoresin (%))	Essential oil (%)
Kerala Agricultural University, Thrissur						
Kanti	37.7	240-270	20.2	7.2	8.3	5.2
Sohba	35.9	240-270	19.4	7.4	9.7	4.2
Sona	21.3	240-270	18.9	7.1	10.3	4.2
Varna	21.9	240-270	19.1	7.9	110.8	4.6
Sardarkrushinagar Dantiwada Agricultural University, Jagudan						
Sugandham	15	210	23.3	3.1	11	2.7

Phenological Growth Stages of Turmeric

PLANTING TO ESTABLISHMENT STAGE (0 - 30 DAYS):

The planting of turmeric is done by using mother rhizomes and finger rhizomes through different planting methods like the raised bed method and broad bed furrow method of planting etc. Before planting the rhizomes, it should be treated with bio-fungicides and biofertilisers to prevent the infestation of soil-borne diseases as well as make nutrients available to the plants. The row-to-row and plant-to-plant spacing varies with the type of soil and water availability for irrigation. The germination starts after the 20th day of planting and is completed after 40 days of planting.

Figure 2: *Planting to establishment stage*

VEGETATIVE STAGE (31 - 125 DAYS):

After germination, the vegetative stage starts from the early seedling stage in the late tillering stage of the crop. After 75-90 days of turmeric planting, 3 to 4 leaves develop. In the vegetative stage, tiller formation occurs in the plant and it ranges from 4 to 6 tillers per mother plant. Tillering is a crucial stage for the nutrient and moisture management of plants. If the nutrient and moisture stress occurs during the tillering stage then it affects the tiller formation and overall, the productivity of the turmeric.

Figure 3: *Vegetative growth stage*

RHIZOME INITIATION AND DEVELOPMENT STAGE (125 - 235 DAYS):

The rhizome initiation in the turmeric starts after the tiller development stage approximately 130-140 days after planting. During the rhizome initiation and development stage, earthing up should be done to avoid the exposure of the rhizome to direct sunlight.

Figure 4: *Rhizome initiation and development stage*

MATURITY (236 - 270 DAYS):

During the maturity stage of turmeric, the size and weight of the rhizome increases. Turmeric becomes ready for harvesting after 260 - 270 days after planting. At the time of maturity, the leaves and stems of turmeric start to turn brown and dry.

Figure 5: *Maturity stage*

Methods of planting

The plantation of turmeric is generally done by ridges and furrow and broad bed furrow methods of planting.

RIDGES AND FURROW METHOD:

Prepare ridges and furrows with the help of a ridger at a 60-75 cm distance, depending upon the type of soil. Planting should be done on both sides of the ridge at a 30 cm distance between the two plants.

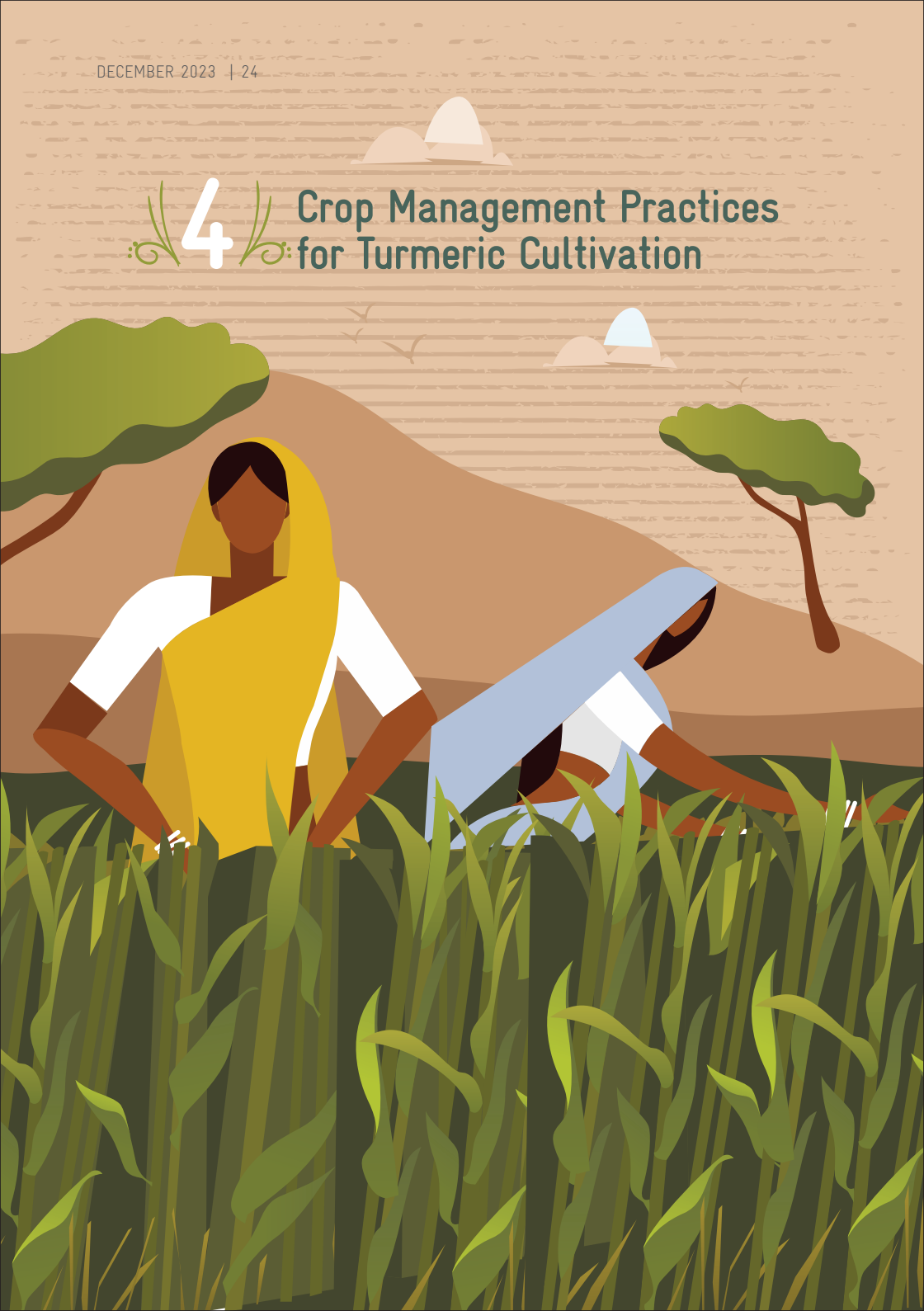
Figure 6: *Ridges and furrow method of planting*

Source: Jaisankar, C. (2016, September 22). Turmeric farmers looking at bumper harvest. The Hindu.

BROAD BED FURROW METHOD (BBF):

Prepare a broad bed of 1.2 m width with 20-30 cm height, on the top the of bed, the width should be about 60-75 cm wide. Keep at least 50 cm spacing between the beds. On the top of the bed, plant two rows of turmeric at a spacing of 30 cm between the row and plants leaving a 15 cm distance from both sides of the ridge.

4 Crop Management Practices for Turmeric Cultivation

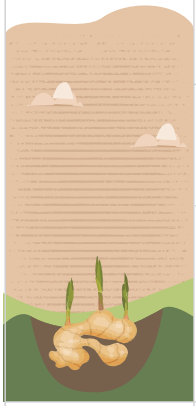


Crop Management Practices According to the Standard Meteorological Week (SMW) and Phenological Growth Stages

Phenological stage	SMW	Days After Planting	Crop Management Practices
Land preparation 	16-17	-45	• Select well drained fertile soil having pH 6.5-7.5 for the cultivation of turmeric. Soil testing should be done for major and micronutrients. Based on the available nutrients in the soil, balanced nutrient management should be done. If the soil is deficit in micro-nutrients and calcareous, then apply respective micronutrients at the time of bed formation. • In the summer season, ploughing should be done about 20 cm deep. Ploughing should be done early in the morning or late in the evening.
	21	-15	• One month after the ploughing (2-3 harrowings) should be done followed by planking to prepare a good tilth.
			• The second harrowing removes the crop residues of the previous crop from the field.
			• Incorporate well decomposed Farm Yard Manure (FYM) at 35-40 tonnes /ha or vermicompost at10 tonnes/ha at the time of the last harrowing.
			• Incorporate crop residues of cabbage and mustard if available in the soil to prevent the infestation of soil-borne diseases.

Phenological stage	SMW	Days After Planting	Crop Management Practices
	22	-10	**Intercropping:** • In turmeric, intercropping should be done with Black Gram, Green Gram, Onion, Soybean and Marigold. Planting of seasonal flower crops like marigold, sunflower etc. along the field border to attract beneficial insects/natural enemies to control pests and diseases.
Land preparation 	22-23	-5	• Prepare a bed for the plantation of turmeric as per the soil type and availability of irrigation. • Apply neem or karanj cake at 250 kg/ ha at the time of bed preparation. • Prepare ridges-furrows with the help of a ridger at 60-75 cm distance depending upon the type of the soil. • Planting should be done on both sides of the ridge at 30 cm distance between the plants and 30 cm between the rows. OR • Prepare a broad bed of 1.2 m width with 20-30 cm height, on the top of the bed width should be about 60-75 cm wide. Keep at least 50 cm spacing between the beds. In the broad bed method, rhizome planting should be done at a distance of 30 x 30 cm leaving 15 cm space from both sides of the rhizome.

Phenological stage	SMW	Days After Planting	Crop Management Practices
Plantation 	24-25	0	**Selection of the planting materials:** • Planting material should be free from pests and disease infestation. • The selection of planting material should be done based on the size of the mother rhizomes and their quality. • There are mainly three types of rhizomes used for the planting of turmeric. • Mother rhizome more than 50 g in weight. • Daughter rhizome more than 40 g in weight. • Fingers rhizome more than 30 g in weight. • Seed rate of finger rhizome - 2000 - 2500 kg/ha. • Apply water over the planting material regularly before 15 days of planting to ensure good germination. **Rhizome treatment:** • Prepare a solution of 2 kg azotobacter + 2 kg PSB + 5 kg fresh cow dung, mix in 50 litres of water and keep the seed rhizomes in a solution for 15 - 20 minutes, then use for planting. • Rhizomes should be treated with *Trichoderma viride* at 4 g per kg of seeds to prevent the infestation of seeds and soil borne diseases.

Phenological stage	SMW	Days After Planting	Crop Management Practices
Germination stage 	25	5	• If the crop requires irrigation, then provide light irrigation for proper germination of the crop. • Avoid excess use of nitrogenous fertilisers to avoid infestation of Rhizome rot and Bacterial wilt.
	29	30	• Weeding should be done to keep weed free plot and reduce evaporation losses from the soil.
	30	35	• Spray amrutpani 150 ml + vermiwash 500 ml per 15 litres of water to enhance growth and development of the crop, increase resistance to pests and disease infestation.
Vegetative stage	32	45	• For better white root growth and development at the seedling stage, mix Mycorrhiza at 1 kg + Humic Acid at 1 kg in 200 litres of water and apply for 1- acre area.
	33	50	• Application of jeevamrut at 200 litres per acre along with irrigation. Jeevamrut application enhances microbial activities in the soil and makes nutrients available to the crop.
		55	• Drenching should be done with Metarhizium anisopili at 5 ml per litre of water to prevent the infestation of white grub.
	34	65	• Weeding should be done to keep the plot weed free and reduce evaporation losses from the soil.

Phenological stage	SMW	Days After Planting	Crop Management Practices
Vegetative stage 	55	75	• Spray organic formulations like Amrutpani 150 ml + vermiwash 500 ml per 15 litres of water to enhance growth and development of the crop and increase resistance to pests and disease infestation. • If you observed the infestation of rhizome rot and bacterial wilt then drenching should be done with trichoderma viride at 5 ml/litre of water to control the disease infestation.
	36	80	• For better white root growth development at the seedling stage, mix Mycorrhiza at 1 kg + Humic Acid at 1 kg in 200 litres of water for drenching one acre area. • If you observed the infestation of stem borer and leaf roller, then spray botanical pesticide like Dashparni ark at 150 ml per 15 litres of water.
	37	85	• Earthing up should be done about 80 - 85 days after planting. Earthing up provides support to the plants and covers the exposed rhizomes with the soil, so it enhances the growth and development of the rhizomes. • Mix 3 kg of trichoderma + 10 kg of vermicompost and keep it for 10 days, then apply at the time of earthing up to prevent and control the infestation of rhizome rot and soft rot disease in turmeric.

Phenological stage	SMW	Days After Planting	Crop Management Practices
Vegetative stage 	38	90	• Application of jeevamrut at 200 litres per acre along with irrigation. Jeevamrut application enhances microbial activities in the soil and makes nutrients available to the crop. • Drenching should be done with tricho-derma viride at 5 ml/litre of water to control the disease infestation.
	39	90 100	• Spray amrutpani 150 ml + vermiwash 500 ml per 15 litres of water to enhance growth and development of crops and increase resistance to pests and disease infestation. • Weeding should be done to keep the plot weed free and reduce evapo-ration losses from the soil.
	40	100 120	• Application of jeevamrut at 200 litres per acre along with irrigation. Jeevamrut application enhances microbial activities in the soil and makes nutrients available to the crop. • If you observed the infestation of stem borer in the field then spray 1% neem oil at 3 ml/litre of water.
	40	100 120	• Install light trap at 1/ acre and operate between 6 - 9 pm to monitor and control the stem borer infestation. • Earthing up should be done within 100 days after planting to provide support to the plants and cover the exposed rhizomes with the soil, so it enhances the growth and development of the rhizomes. Mix fertilisers in the soil. • Cover the exposed rhizomes or fingers of turmeric with the soil to prevent the infestation of rhizome fly.

Phenological stage	SMW	Days After Planting	Crop Management Practices
Vegetative stage	42	130	• Apply jeevamrut at 200 litres per acre along with irrigation.
	43	130 140	• Spray amrutpani 150 ml + vermiwash 500 ml per 15 litres of water. • If you observed the infestation of rhizome rot and bacterial wilt then drenching should be done with trichoderma viride at 5 ml/litre of water to control the disease infestation. • Weeding should be done to keep the plot free from weeds and reduce evaporation losses from the soil.
Rhizome initiation and development stage 	45	140 150	• Spray amrutpani 150 ml + vermiwash 500 ml per 15 litres of water. • Apply Jeevamrut at 200 litres per acre at optimum moisture level. If soil moisture is not sufficient then apply Jeevamrut along with irrigation. • Exposure of turmeric fingers to sunlight causes greening of fingers, which then adversely affects the finger growth and quality. So, cover the exposed fingers with the soil. • Cover the exposed rhizomes or fingers of turmeric with the soil to prevent the infestation of rhizome fly.
	47	160	• Foliar application of potassium sulphate (0:0:50) at 100 g/10 litres of water to increase the size and weight of the fingers. • If you observed the infestation of rhizome rot and bacterial wilt then drenching should be done with trichoderma viride at 5 ml/litre of water to control the disease infestation.

Phenological stage	SMW	Days After Planting	Crop Management Practices
Rhizome initiation and development stage	48	160 170	• Application of Jeevamrut at 200 litres per acre at optimum moisture level. If soil moisture is not sufficient then apply Jeevamrut along with irrigation. • Apply 375 g each of Boron, Iron and Zinc as Borax, Ferrous sulphate, Zinc sulphate + 375 g of urea in 500 litres of water for one hectare area.
	50	180	• Foliar application of potassium sulphate (0:0:50) at 100 g/10 litres of water to increase the size and weight of the fingers.
		200	• Application of Jeevamrut at 200 litres per acre at optimum moisture level. If soil moisture is not sufficient then apply Jeevamrut along with irrigation. • Cover the exposed rhizomes or fingers of turmeric with the soil to prevent the infestation of rhizome fly.
	1	215	• Spray 19:19:19 500g + MgSO4 100g + FeSo4 50 g +100 litres of water to enhance the growth and development of the fingers.
	3	230	• Spray 19:19:19 500g + MgSO4 100g + FeSO4 50 g + 100 litres of water to enhance the growth and development of the fingers.

Phenological stage	SMW	Days After Planting	Crop Management Practices
Maturity and harvesting 	8	240 260	• At maturity, the leaves of turmeric turn yellow. Irrigation should be stopped at this stage. • Drying of leaves shows the sign of maturity of the crop. • In black soil about 60% drying of leaves and in light soil 80% drying of leaves is the indication of maturity level.

5 Harvesting and Post harvest processing of Turmeric

Harvesting and Post Processing of Turmeric

- Turmeric is ready for harvest in 7-9 months depending on the variety and time of sowing.
- The crop is generally harvested from January to March.
- On maturity, the leaves turn dry and are light brown to yellowish in colour.
- Harvesting is done either manually or by using a tractor.

1. Manual Harvesting:

The land is ploughed, clumps are carefully lifted with spade and the rhizomes are gathered by hand picking.

2. Mechanical Harvesting:

Harvesting with a tractor-drawn turmeric harvester is followed if the cultivation is on the raised beds.

- The harvested rhizomes are collected manually and should be cleaned by removing all the extraneous matter adhering to them.

PRESERVATION OF SEED RHIZOMES

- Rhizomes for seed purposes are generally stored by heaping in well-ventilated rooms and covering them with turmeric leaves.
- The pits are to be covered with wooden planks with one or two openings to be stored in pits with saw dust, sand with leaves of Stychnos nux-vomica (Kanjiram).
- Improved techniques.
- Use of hermetic bags for storage or cocoons.

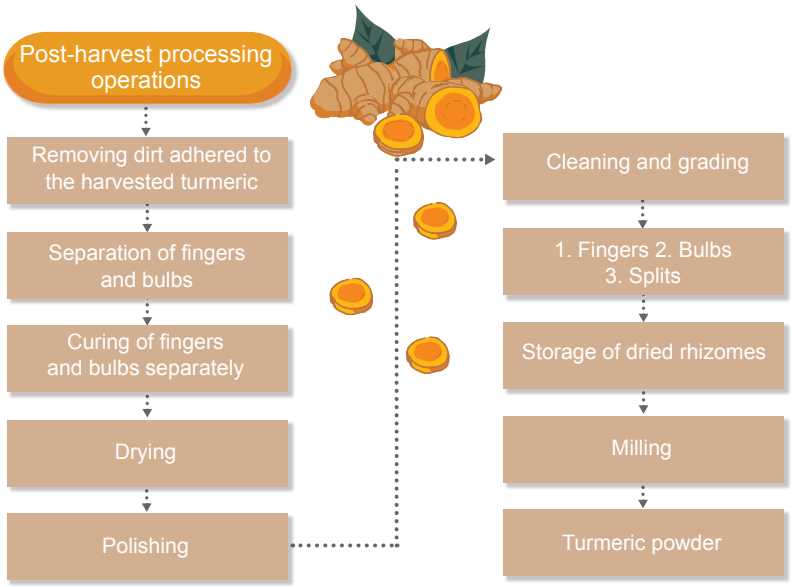
FEATURES OF HERMETIC BAGS

- Portable, gas-tight, moisture-tight and reusable.
- 500 times more airtight than normal plastics.
- Protects against mould growth and insect infestation.
- Retains taste, colour and aroma.
- Maintains germination and vigour of stored seeds
- Preserves quality for long periods of storage (up to 1 year).
- Fit for storage of organic products.

POST-HARVEST PROCESSING

- The harvested turmeric rhizomes before entering the market, are converted into a stable commodity through a number of post-harvest processing operations like boiling, drying and polishing. Boiling of turmeric is taken up within 3 or 4 days after harvest.

POST-HARVEST UNIT OPERATIONS IN TURMERIC PROCESSING



CLEANING

Remove the dirt adhered to Turmeric after harvesting.

Figure 7: *Cleaning of Turmeric after harvesting*

SEPARATION OF FINGERS AND BULBS

As they both require different curing times, separate them accordingly.

CURING

- Curing is the first post-harvest operation to be performed at the farm level which involves cooking fresh rhizomes in water until soft before drying.
- Boiling destroys the vitality of fresh rhizomes, avoids the raw odour, reduces the drying time and yields uniformly coloured products.
- Pressure boiling has become the most advanced method in terms of saving time in boiling, drying, efficient energy use and quality retention.
- It prevents the leaching of Curcumin which occurs in the case of traditional methods of boiling.
- The loss of colour observed in turmeric, is 1.5 - 2.5% in steam cooking whereas in boiling it is 1.6 - 3.5%.
- Thus, the process of steam treatment is suggested to the turmeric business which is beneficial to farmers and turmeric process industries.

Figure 8: *Curing of Turmeric*

PRESSURE BOILING

- The steam is penetrated into the rhizomes up to its absorption capacity.
- The curing system consists of a boiler, cooking vessels, valves and pipes.
- The turmeric rhizomes are filled into the perforated cooking vessels which have holes at the bottom for releasing steam to indicate completion of cooking.
- Water is poured into the boiler keeping the required space for accumulation of steam under pressure. The pressure gauge is provided on the boiler to indicate the required pressure. Fuel is put into the furnace of boiler manually.
- Turmeric leaves and agricultural waste are used as fuel.
- Insulation is provided to the cooking vessel to reduce heat losses.

DRYING

- The cooked fingers are dried in the sun by spreading them in 5-7 cm thick layers on the drying floor.
- A thin layer is not desirable, as the colour of the dried product may be adversely affected.
- During night time, the material should be heaped or covered. It may take 15-20 days for the rhizome to become completely dry.

- During drying moisture content reduces from 90% - 8-10%.
- When the dried finger breaks cleanly with a metallic sound, it is sufficiently dry.
- Drying of turmeric is a crucial post-harvesting process to reduce fungal and bacterial growth.
- Dried product in the solar dryer has improved shelf life, easy to handle, easy to pack, and has reduced bacterial growth.

Figure 9: *Drying of Turmeric*

POLISHING

- The appearance of dried turmeric is improved by smoothening and polishing the outer surface by manual or mechanical rubbing.
- Polishing is done till the recommended polish of 7- 8% is achieved.
- Polishing of dried turmeric also helps in removing the wrinkles.
- In an improved method, polishing is done by using hand-operated barrel or drum mounted on a central axis, the sides of which are made of expanded metal screen.
- When the drum filled with turmeric is rotated, polishing is affected by abrasion of the surface against each other as they roll inside the drum.

Figure 10: *Polishing of Turmeric*

Usually, 5 – 8% of the weight of turmeric is the polishing wastage during full polishing and 2 to 3% during half polishing.

COLOURING

- The colour of the processed turmeric influences the price of the produce. Hence, to obtain attractive product, turmeric powder is sprinkled during the last phase of polishing.

CLEANING

- Turmeric being a natural produce, is bound to gather contaminants during various stages of processing. Thus, it should be cleaned by removing such foreign materials.
- A sifter, destoner, and an air screen separator will help remove materials such as stones, dead insects, excreta, and other extraneous matter.

GRADING

- Although Indian turmeric is considered to be the best in the world, about 90% of the total produce is consumed internally and only a small portion of the production is exported.
- Turmeric of commerce is described in three ways:

1. **Fingers:** These are the lateral branches or secondary 'daughter' rhizomes which are detached from the central rhizome before curing. Size: 2.5 - 7.5 cm in length and may be over 1 cm in diameter.
2. **Bulbs:** These are central 'mother' rhizomes, which are ovate in shape and are of shorter length and have larger diameter than the fingers.
3. **Splits:** Splits are the bulbs that have been split into halves or quarters to facilitate curing and subsequent drying.

PACKING

- Cleaned and graded material is packed generally in new double burlap gunny bags and stored over wooden pallets in a cool, dry place protected from light.

STORAGE

- The stores should be clean and free from infestation of pests and harbourage of rodents.
- It is not recommended to apply pesticides on the dried/polished turmeric to prevent storage pests.
- Hermetic bags can be used for storage which protects the turmeric against mould growth and insect infestation.

6 Symptoms of Major Pests and Diseases of Turmeric and their Management

Symptoms of Major Pests and Diseases of Turmeric and their Management

SHOOT BORER

Symptoms:

- Larvae bore into the pseudo stems and feed on the growing shoot resulting in yellowing and drying of the infested shoots.
- The presence of a borehole on the pseudo stem and the withered central shoot is a characteristic symptom of pest infestation.

Preventive Measures:

- Deep ploughing should be done in summer.
- Select healthy and pest free rhizomes for planting.
- Apply castor or neem cake at 200 kg/acre.
- Remove egg masses, larva and pupa and destroy it.
- Install light trap at 1/acre and operate between 6-10 pm. Collect and kill the trapped moths.

Curative Measures:

- Release egg parasitoids Trichogramma chilonis at 40,000/acre.
- Spray 5% NSKE at the initial crop stage.
- Spray dashparni ark at 150 ml/15 litres of water.

RHIZOME FLY

Symptoms:

- The maggots feed on the rhizome as a resulting in yellowing of the plants.

Preventive Measures:

- Deep ploughing should be done in summer.
- Apply neem cake at 200 kg/ acre.
- Select rhizome fly resistant varieties for planting. Eg. waygav, kasturi and durgarala.
- Select healthy and pest free rhizome for planting.
- Cover the exposed rhizomes or fingers of turmeric with the soil to prevent the infestation of rhizome fly.
- Remove and destroy rotting rhizomes along with the maggots from the field after the harvest of the crop.

Curative Measures:

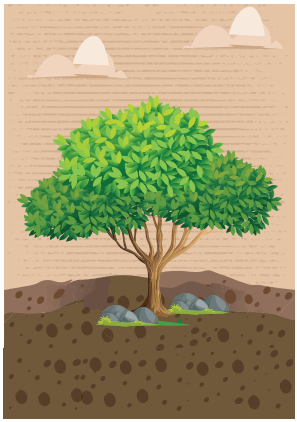
- Spay 5% NSKE to control rhizome flies.
- Conservation of Ladybird Beetle at 100000 adults within the field.

WHITE GRUB

Symptoms:

- Grub feeds on the rhizome of the plant.
- Grub feeds on the functional roots of the plant, leaving behind only tap roots.
- Grub-infested plants turn leaves pale and the branches drop down, the plant withers and can be easily uprooted.

Preventive Measures:



- Installation of light trap at 1 near neem or babul tree after the first summer shower.
- Shaking of neem and babul trees in the evening time after pre monsoon shower. Collection of fallen adult and their destruction.
- Collection and destruction of grub stage along with infested rhizomes.

Curative Measures:

- Drenching with Metarhizium anisopliae at 5 ml/litre of water.
- Drenching with Beauveria bassiana at 5 ml/litre of water around the affected plants.

LEAF SPOT

Symptoms:

- Many brown spots appear of various sizes on the upper surface of the young leaves.
- Later, spots may coalesce and form an irregular patch covering almost the whole leaf.

Preventive Measures:

- Deep ploughing should be done in summer.
- Pluck and remove the infested leaf and uproot the infected plants and destroy them.
- Field sanitation and avoiding water stagnation in the field.

Curative measures:

Cultural control:

- Pluck and remove the infested leaf and uproot the infested plants and destroy them.
- Use proper green mulching to reduce soil splashes.

Biological control:

- Use of plant extracts such as garlic extracts is effective against foliar pathogens.
- Spray an extract of asafoetida, turmeric and water pathogens including nematodes.

RHIZOME ROT

Symptoms:

- Rhizome rot starting from the margins dries the leaves.
- Affected rhizome is easily uprooted from the soil.
- The rhizomes decay as a result of the attack of the fungus. An offensive smell occurs when rhizome uproot.

Rhizome should be treated with Trichoderma viride at 500g/100 litre of water. Keep the rhizome inside the solution for 10 minutes.

Preventive Measures:

- Deep ploughing should be done in summer.
- Apply 200 kg neem cake per acre before planting.
- Crop rotation with maize, cotton and ragi, paddy, maize, sorghum etc.
- Planting of disease-free seed rhizomes.
- Remove affected plants from the field and destroy them.

Cultural control:

- Maintain proper drainage by using 30 cm raised bed and avoiding water stagnation.
- Adopt phytosanitary measures like infected plants should be uprooted and destroyed.
- Mulching with green leaves (Lantana camara and Vitex negundo) at 4- 4.8 t/acre at the time of planting. (It is repeated at 5 t/acre 40 and 90 days after planting).

Curative Measures:

- Drenching with Trichoderma viride at 50 g/10 litres of water.
- Mix Pseudomonas fluorescens at 1 kg in 500 kg well decomposed FYM and apply for one acre area.
- Drenching with Pseudomonas fluorescens at 50 g/10 litres of water around the affected plants.

- Foliar application of neem oil at 0.5% twice at fortnightly intervals.
- Cow dung slurry or liquid manure may be poured on the bed after each mulching to enhance microbial activity and nutrient availability.
- Use Fermented Plant Extract (FPE) prepared by using (garlic + onion leaves + Cannabis sp + wild poisonous plant) + (cow urine) + (EM solution) + (extract after washing polished rice) + (alcohol) + (water) (1:1:1:1:1:15), sufficient for 1.0 ha for seed treatment against rhizome rot.

7 Certification for Farm Sustainability Assessment (FSA)

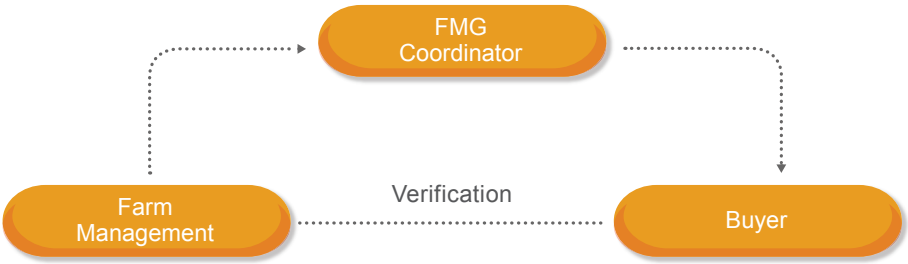
Certification for Farm Sustainability Assessment

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 it 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 60 | Sustainable Production Practices for Cumin Management 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.

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 an 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 organised 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 allow 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:

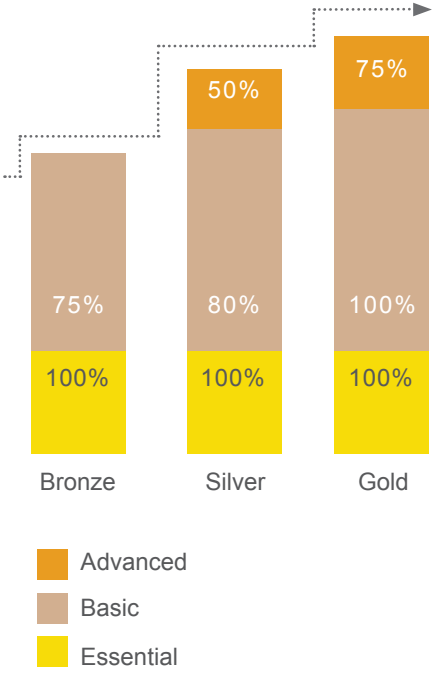
- Bronze Compliance with 100% 'Essential' questions and;
- A minimum of 75% 'Basic' questions.

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 farms operate, 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

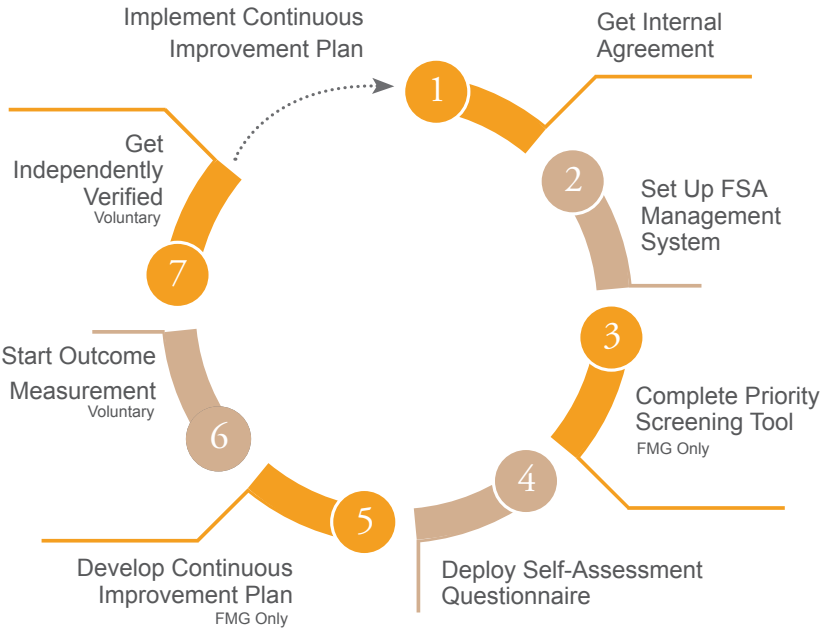
The Benchmarking Module allows agricultural sustainability schemes to be benchmarked against the FSA Self-Assessment Questionnaire and FSA normative documents.

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 Coordinator 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

- 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.
- 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.
- 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 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.

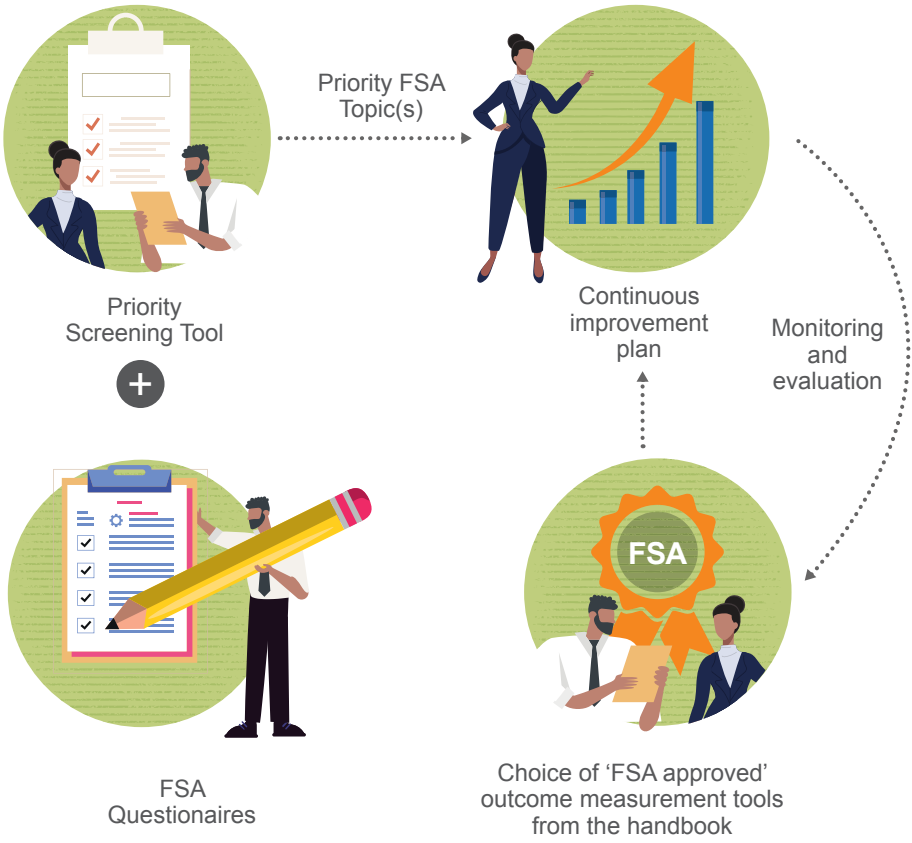
Step 5: Develop Continuous Improvement Plan

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 in 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.

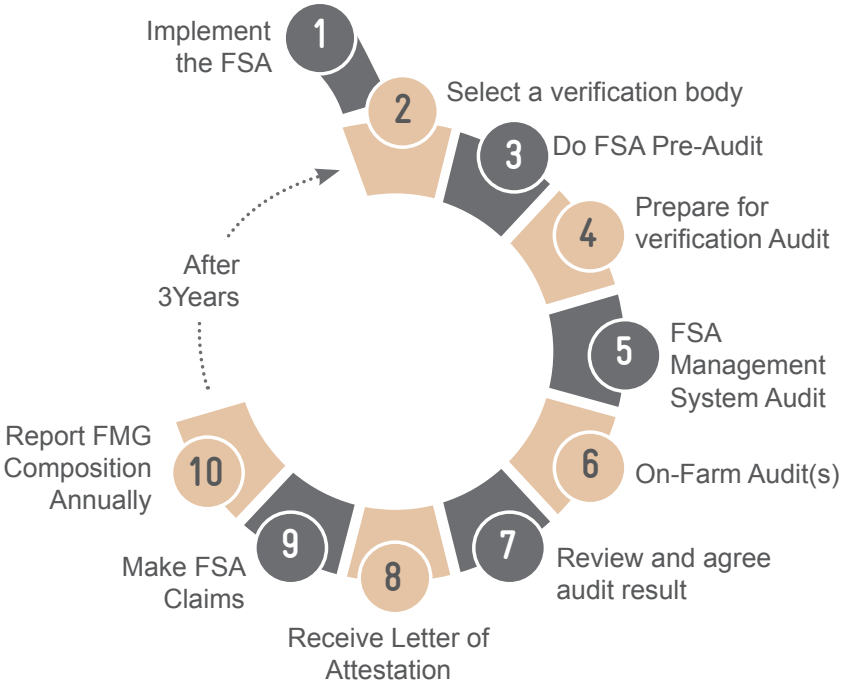
Outcome Measurement Pathway



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 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.

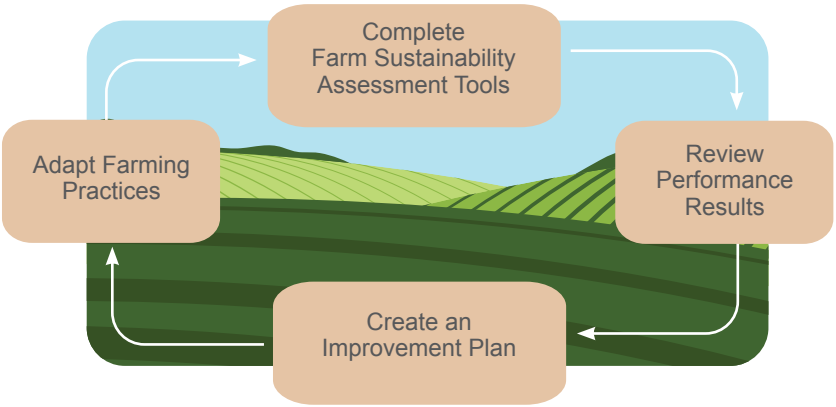
Step 3: How to Calculate Your Performance Score?

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 Turmeric 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 ETL (Economic Threshold Level).

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.

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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' group will 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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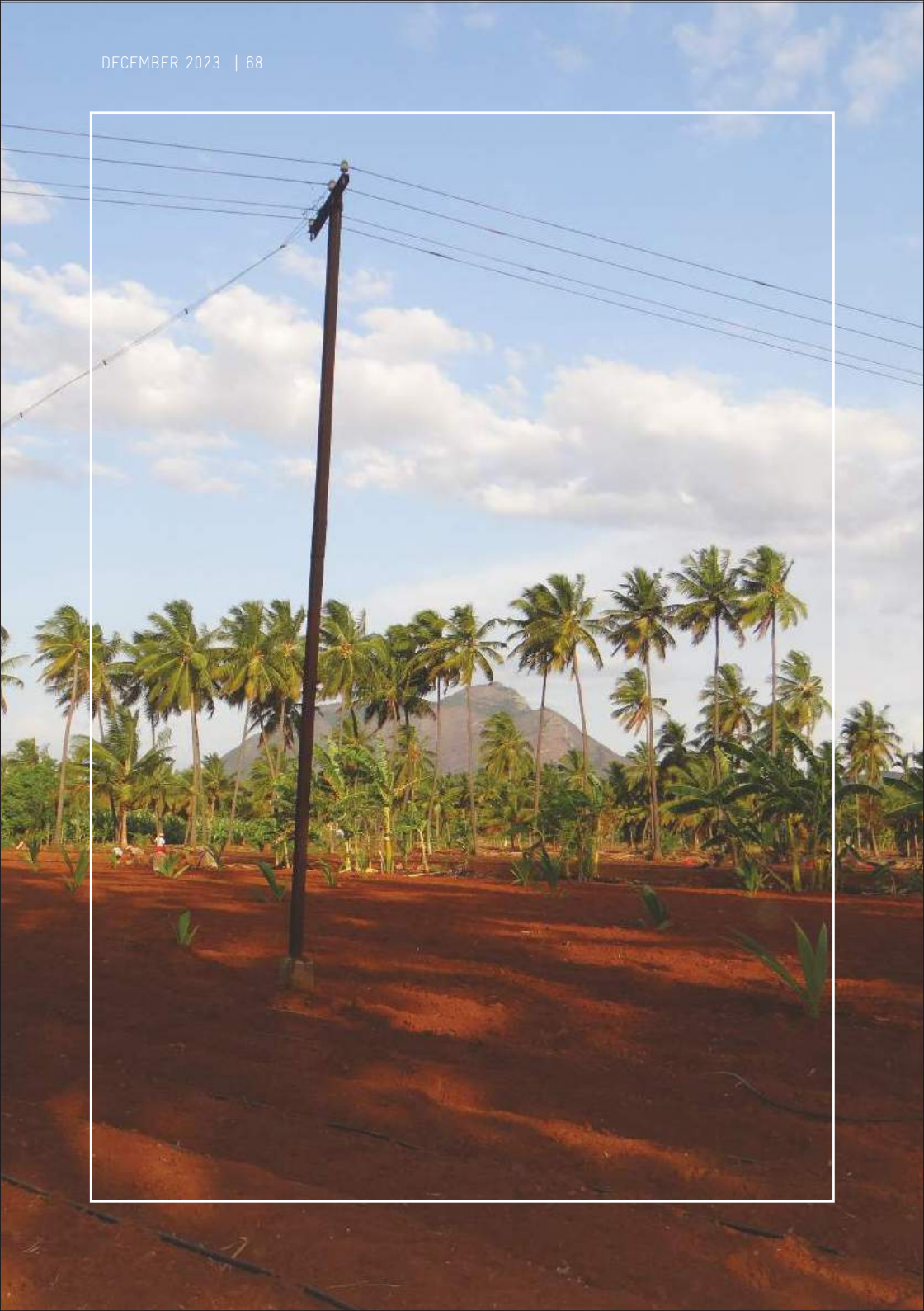

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