
TRAINING MODULE

**Assessment of Farmer Producer Organizations (FPO/FPC) &
their Commodity Specific Value Chain for Agribusiness in
Karnataka**

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Module 1: Introduction to Millets and Solar DRE technologies

Module Overview:

- Importance of millets and their potential
- Overview of Solar DRE technologies and their relevance to millet farming
- Benefits of Solar DRE technologies in millet processing and value addition

Importance of millets and their potential

India is the largest producer of millets in the world. In India millets are grown in 21 states. There is a major impetus in Rajasthan, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, Kerala, Telangana, Uttarakhand, Jharkhand, Madhya Pradesh, Haryana and Gujarat.

In India, millets are cultivated in an area of 12.45 million hectares, producing 15.53 million tonnes with a yield of 1247kg/ha. Sorghum is the fourth most important food grain grown in India after rice, wheat and maize in terms of area (3.84 million hectare) and production (4.31 million tonnes). Bajra (7.05 million hectare) is contributing more than 50% of the area under millets with nearly equal percentage of production. It is interesting to note that, India is the topmost producer of Barnyard (99.9%), finger millet (53.3%), kodo (100%), Little millet (100%) and pearl millet (44.5%) producing about 12.46 million metric tonnes from an area of 8.87 million ha.

Millets and the nutritional benefits:

Millet grains are rich sources of nutrients like carbohydrate, protein, dietary fibre, good- quality fat and have substantially higher amounts of minerals like calcium, potassium, magnesium, iron, manganese, zinc, and B complex vitamins, making them a preferable choice over the cereal grains.

Based on the nutritional composition table compiled (Table 1) from the Indian Food Composition Table (IFCT), 2017 released by ICMR- National Institute of Nutrition (NIN), and Nutritive Value of Indian foods written by Gopalan et al., 2004. The below nutritive values Millets are compared with rice and wheat.

1. Calcium – Finger millet - ragi (364 mg)
2. Fat – Pearl millet (5.43 g)
3. Protein – Proso millet (12.50 g)
4. Dietary fibre – Pearl millet (11.49 g)
5. Magnesium – Proso millet (153 mg)
6. Zinc – Barnyard millet (3 mg)

7. Iron – Pearl millet (6.42 mg), Barnyard millet (5 mg)
8. Folic acid – Kodo millet (39.49 µg), Sorghum (39.42 µg)

Current utilization of millets

Millets are hardy, drought-resistant crops that can grow in poor soil conditions and have a short growing season, making them a valuable crop for farmers in dry regions. Millets are also highly nutritious, rich in fiber, protein, and various vitamins and minerals.

Human consumption of millets varies widely across different cultures and regions. In some parts of the world, such as India and Africa, millets are a staple food and are consumed in various forms, including as porridge, bread, and flatbreads. They are also used to make fermented beverages, such as beer and sourdough bread.

In industrial consumption, millets are used in various ways, such as animal feed, biofuel, and in the production of various food products such as breakfast cereals, snacks, and baked goods. The gluten-free nature of millets has also made them a popular ingredient in gluten-free products.

In recent years, there has been a growing interest in the health benefits of millets, which has led to an increase in their consumption and use in various food products. Millets are also being promoted as a sustainable crop that can help to address issues such as food insecurity and climate change, by providing a more resilient and environmentally friendly alternative to traditional crops.

Millets have great potential in India for various reasons:

1. **Climate Resilience:** Millets are highly climate-resilient and can grow in dry and arid regions with low rainfall. They are also resistant to pests and diseases, making them a low input crop.
2. **Nutritional Value:** Millets are highly nutritious, rich in fiber, protein, and micronutrients like iron, calcium, and zinc. They are also gluten-free, making them a great option for people with gluten allergies or sensitivities.
3. **Food Security:** Millets are an important staple food in many parts of India, especially in rural areas. They are affordable and easily accessible, making them a key contributor to food security.
4. **Income Generation:** Growing millets can be a profitable enterprise for farmers, especially as they are in high demand due to their health benefits. Millet-based products like flour, snacks, and breakfast cereals are also gaining popularity, creating opportunities for small-scale entrepreneurs.
5. **Environmental Sustainability:** Millets require less water and fertilizers compared to other crops like rice and wheat, making them an eco-friendly option for farmers.

In summary, the potential of millets in India is significant as they offer a sustainable, nutritious, and profitable option for farmers while contributing to food security and environmental sustainability.

Consumption of millets as direct food has significantly declined in India due to policies centered around Green Revolution-led food security from the 1960s onwards. During the journey towards food security, nutritional security was not the primary focus, which has resulted in the current state of malnutrition and the rise of Non-Communicable Diseases (NCDs). The transformative role of millets in tackling lifestyle diseases, the benefits of mainstreaming millets in public-funded programs and the growing realization of huge potential for export markets, especially, in midst of the Covid-19 pandemic are projecting them as immune boosters owing to their rich nutritional profile. It is presumed that the world is looking towards India's traditional foods, and it turned to be the mandate of the Government of India to scale up the interventions for increasing the millets area and production, diversifying the processing machinery and technologies, expanding the private food processing ecosystem and thus to cater to the various segments in domestic and export markets.

Overview of Solar DRE technologies and their relevance to millet farming

In recent years, a variety of decentralised renewable energy (DRE) livelihood applications have been developed, which are not only energy- efficient but also economically viable. DRE-powered livelihood solutions have the potential to reduce and eventually eliminate the reliance of livelihood on diesel, particularly in rural settings, and can supplement the grid supply.

These include a myriad of solutions such as solar dryer, solar or biomass powered cold storage/chiller, solar charkha, etc. The modular design of such DRE livelihood applications ensures scalability without large investments. Besides, the energy efficiency of such solutions is also important, as it, in turn, enhances their economic viability by reducing the size of the generation and storage requirement.

Solar Distributed Renewable Energy (DRE) technologies refer to renewable energy systems that are designed to provide decentralized and off-grid energy solutions to rural and remote areas. These technologies are often based on solar power, which is a clean and abundant source of energy in many parts of the world.

In the context of millet farming, Solar DRE technologies can be highly relevant in several ways. Millet is a crop that is commonly grown in semi-arid regions, where access to reliable and affordable energy is often limited. Solar DRE technologies can help to address this challenge by providing power for irrigation, crop processing, and storage, among other applications. Some examples of Solar DRE technologies that are relevant to millet farming include:

1. **Solar water pumps:** Solar water pumps can be used to provide irrigation for millet crops, which can improve yields and reduce water stress. These pumps are powered by solar panels, which makes them more affordable and reliable than diesel or electric pumps.
2. **Solar dryers:** Solar dryers can be used to dry millet crops after harvest, which is an important step in the processing of the crop. Solar dryers can be more energy-efficient and affordable than traditional fuel-based dryers.
3. **Solar-powered storage:** Solar-powered storage systems can be used to store millet crops after harvest. These systems can help to preserve the quality of the crop and reduce post-harvest losses, which can be a significant challenge in many rural areas.
4. **Solar-powered milling:** Solar-powered milling machines can be used to process millet crops into flour, which can be used for a variety of food products. Solar-powered milling machines are more affordable and sustainable than traditional fuel-based milling machines.

Overall, Solar DRE technologies can be highly relevant to millet farming by providing reliable and affordable energy solutions for irrigation, processing, and storage of the crop. These technologies can help to improve the productivity and profitability of millet farming, while also contributing to sustainable development and reducing greenhouse gas emissions.

Module 2: Millet cultivation practices

Module Overview:

- Types of millets and their cultivation practices (Soil preparation, sowing, Weed management and pest control methods and harvesting techniques)

Learning Objectives:

- Understand the different types of millets and their nutritional benefits
- Recognize the soil preparation techniques for millet cultivation
- Identify the sowing techniques for different types of millets
- Learn about weed management and pest control methods for millet cultivation
- Understand the harvesting techniques for different types of millets
- Understand the challenges and opportunities in millet cultivation
- Develop strategies for promoting millet cultivation among farmers

Types of millets

Introduction to different types of millets- Millet is a group of small-seeded grasses that are grown in many parts of the world for their grain. The cultivation practices for millet can vary depending on the specific type of millet being grown and the environmental conditions in which it is being grown.

1. Sorghum millet/Jowar:

Grows in warm, arid climates receive around 45-100 cm of rainfall annually. Temperature requirements are around 20-35 degrees Celsius in the Kharif season and around 15 degrees Celsius in the Rabi season.

Grows well in sandy loamy soils having good drainage and humus with a pH range from 6-7.5. Maharashtra is the largest producer of Jowar in India.

2. Finger millet/Ragi:

Grows in high altitudes, with extreme climatic conditions. Requires dry spell at the time of grain ripening and receives around 70-120 cm of rainfall annually. Temperature requirements are around 25-30 degrees Celsius. Grows well in red, black, sandy, loamy, and lateritic soils with pH of about 4.5-8. Karnataka is the largest producer of Ragi in India.

3. Pearl millet/Bajra:

Grows in moist weather conditions as Kharif crops need irrigation. Requires 40-50 cm of annual rainfall. Temperature requirements are from 20-30 degrees Celsius.

Grows well in black cotton soil, sandy loamy soil, or upland gravelly soil having good drainage having a low pH value. Rajasthan is the largest producer of Bajra in India.

4. Foxtail millet/Kangni:

- Grows in warm, arid, semi-arid and tropical regions, and can survive poor water assets.
- Requires 50-75 cm of rainfall annually. Temperature requirements are from 15-30 degrees Celsius. Grows well in sandy to loamy soils with a pH of 5.5-7. Andhra Pradesh is the largest producer of Foxtail millet in India.

5. Barnyard millet/Sanwa:

Grows in tropical and sub-tropical regions with an altitude of up to 2100m. Requires 60- 80 cm of rainfall annually. Temperature requirements are from 18-27 degrees Celsius.

Grows well in sandy loam to loamy soil having a sufficient amount of organic matter having pH from 5.5-7.5. The Himalayan hills are the largest producer of Barnyard millet in India.

6. Kodo millet/Kodon:

Grows in a warm and dry climate and is extremely drought-tolerant. Requires 50-60 cm of rainfall annually. Temperature requirements are from 26-29 degrees Celsius.

Grows well in gravelly and stony soil such as in the hilly region having pH from 5.5-7.5. Madhya Pradesh is the largest producer of Kodo millet in India.

7. Proso millet/Chena:

Grown in warm, arid, non-irrigated regions of the world, it is drought-resistant and can tolerate scanty rainfall. Requires 20-50 cm of rainfall annually. Temperature requirements are from 10-45 degrees Celsius.

It is well adapted to many soil types which have a pH of around 5.5-6.5. Madhya Pradesh is the largest producer of Proso millet in India.

II. Soil preparation techniques for millet cultivation

SOIL PREPARATION:-

Millet requires well-drained soil that is rich in organic matter. The soil should be tilled and prepared before sowing the seeds. The ideal soil pH for millet cultivation is between 6.0 and 7.0.

Soil amendments and fertilizers-

Preparation of Main Field

1. Application of FYM or Compost

Spread 12.5 t/ha of FYM or compost or composted coir pith evenly on the unploughed field and then plough and incorporate in the soil.

2. APPLICATION OF FERTILIZERS

- Soil test based fertilizer recommendations may be adopted in Western and North Western Zones in soils of Vertisols, Alfisols, Inceptisols and Entisols for prescribing the fertilizer doses for specified yield targets. In soils having high intensive cropping system viz., Ragi-Maize-Cowpea, having high soil available K potassium need not be applied. Apply NPK fertilizers as per soil test recommendation as far as possible. If soil test recommendation is not available, adopt a blanket recommendation of 60 kg N, 30 kg PO₅ and 30 kg K₂O per ha.
- Apply half the dose of N and full dose of N and full dose of P₂O₅ and K₂O and basally before planting.
- Broadcast the fertilizer mixture over the field before the last ploughing and incorporate into the soil by working a country plough.
- Apply 10 packets/ha (2000 g) of azospirillum and 10 packets (2000 g/ha) of Phosphorous solubilizing bacteria or 20 packets of Azophos (4000 g/ha) after mixing with 25 kg of soil and 25 kg FYM before transplanting.

3. APPLICATION OF MICRONUTRIENT MIXTURE

- Mix 12.5 kg of micronutrient mixture formulated by the Department of Agriculture, Tamil Nadu with enough sand to make a total quantity of 50 kg/ha.
- Apply the mixture evenly on the beds.
- Do not incorporate the mixture in the soil.

III. Sowing techniques for different types of millets

Seed selection and treatment- Good quality seed is essential for successful millet cultivation. The seed should be selected based on its purity, germination rate, and disease resistance.

Sowing techniques for pearl millet, finger millet, foxtail millet, and other millets.

- Treat the seeds with three packets of azospirillum (600 g) and 3 packets of phosphobacteria or 6 packets of Azophos (1200 g/ha).
- The seed is pelletised with 15 g of Chloropyriphos in 150 ml of gum and shade dried.

IV. Weed management and pest control methods for millet cultivation

Weeds problem in ragi crops can be effectively managed by cultural and mechanical measures

Line sowing: 2-3 inter cultivations and one hand weeding

Broadcast crop: 2 effective hand weeding will minimize weeds

In assured rainfall and irrigated areas: Pre-emergence spray: Isoproturon @ 0.5 kg a.i./ha. (Rainfed areas), Oxyflurofen @ 0.1 It.a.i /ha (Irrigated areas)

Post-emergent spray: 2, 4-D sodium salt @ 0.75 kg a.i./ha Spraying around 20-25 days after sowing effectively controls weeds.

Diseases

Finger millet is affected by a variety of diseases of which blast caused by *Pyricularia grisea* is the major problem. The disease is quite severe in kharif crop at all the growth stages. The losses caused will be more if the disease appears in the nursery and on the ears affecting the neck and fingers.

Module 3: Value Added Millet Products

Module Overview:

- Millets as a Superfood
- Introduction to value-added millet products
- Production of millet-based snacks, bakery products, and beverages

Millets as a superfood

1. Sorghum Millet (Jowar)

Sorghum is a cereal grain that's produced widely around the globe. The whole grain is commonly used in baking, and preparing Rotis, while its syrup is used as a natural sweetener.

Jowar is rich in iron, proteins, fibre and B vitamins, which play an essential role in metabolism, neural development, and skin and hair health. It is a healthier alternative for people who are allergic to wheat and contains more antioxidants than blueberries and pomegranates.

100 grams of uncooked sorghum provides:

Calories: 329

Protein: 10.4 grams

Fat: 3.1 grams

Carbohydrates: 70.7 grams

Fibre: 2 grams

2. Finger Millet (Ragi)

Ragi is one of the best millet varieties and is often recommended by fitness enthusiasts as a healthy alternative to rice and/or wheat. For people affected with diabetes, ragi acts as a blood sugar stabilizer and reduces inflammation.

It is also high in calcium and has adequate amounts of iron and other minerals and aids brain development in growing children. Ragi also contains sumptuous amounts of essential amino acids that are essential for your overall development.

100 grams of uncooked Ragi provides:

Calories: 336

Protein: 7.3 grams

Fat: 1.3 grams

Carbohydrates: 72 grams

Fibre: 3.6 grams

3. Foxtail Millet (Kakum/Kangni)

Kakum or Kangni is a healthy substitute for white rice. Loaded with good calories, it is a powerhouse of energy. Foxtail Millet is high in Vitamin B12, which is necessary for a healthy heart, smooth nervous system functioning, and overall good skin and hair growth.

It also contains high quantities of iron that reduces muscular spasms and eases out restless syndrome.

100 grams of uncooked Foxtail provides:

Calories: 351

Protein: 12.3 grams

Fat: 4.3 grams

Carbohydrates: 60.2 grams

Fibre: 6.7 grams

4. Pearl Millet (Bajra)

Bajra, like most millets, is a high-nutrient source of protein, carbohydrates, vitamins, minerals, and plant compounds. It can be prepared in a variety of ways, including roti and khichdi, and has numerous health benefits.

If you're trying to reduce weight, include whole-grain meals with a low-calorie density, such as bajra, in your diet. It's also linked to better outcomes in the treatment of type 2 diabetes and other chronic illnesses.

100 grams of uncooked Bajra provides:

Calories: 363

Protein: 11.8 grams

Fat: 4.8 grams

Carbohydrates: 67 grams

Fibre: 2.3 grams

5. Amaranth Millet (Rajgira/Ramdana/Chola)

Amaranth is a versatile and nutrient-dense grain that has been grown for centuries. It is a high-protein, high-fibre grain that's ideal for a balanced diet. It also aids in the prevention of greying and hair loss.

Rajgira also helps to decrease cholesterol and the risk of cardiovascular disease. Several antioxidants, including gallic acid, p-hydroxybenzoic acid, and vanillic acid, help protect against disease.

100 grams of uncooked Amaranth provides:

Calories: 371

Protein: 14 grams

Fat: 7 grams

Carbohydrates: 65 grams

Fibre: 7 grams

6. Buckwheat Millet (Kuttu)

Kuttu is one of the most prevalent millet varieties and is frequently consumed during the Navratra fasting period. It is diabetic-friendly and aids in reducing blood pressure. It is beneficial for cardiovascular health and should be included in your diet if you wish to lose weight.

Buckwheat also helps to prevent breast cancer, asthma in youngsters, and gallstones. The flavonoids rutin and quercetin are abundant in buckwheat. Rutin helps to strengthen blood vessels, while quercetin aids in inflammation reduction.

100 grams of uncooked Buckwheat provides:

Calories: 343

Protein: 13.25 grams

Fat: 3.4 grams

Carbohydrates: 71.5 grams

Fibre: 2.1 grams

7. Barnyard Millet (Sanwa)

Barnyard millet is alkaline and easily digestible. It helps cleanse your intestines, keeping you from becoming constipated. The high content of antioxidants significantly reduces the risk of Type 2 Diabetes.

For postmenopausal women, barnyard millet has cardiovascular advantages. In the case of jaundice too, barnyard millet is a wonderful choice.

100 grams of uncooked Barnyard provides:

Calories: 300

Protein: 6.2 grams

Fat: 4.8 grams

Carbohydrates: 78.2 grams

Fibre: 1 gram

8. Little Millet (Moraiyo/Kutki/Shavan/Sama)

Usually incorporated in South-Indian dishes, Little Millets are gluten-free, non-acid-forming, and a perfect addition to meals of diet-conscious people. It's a healthier alternative to rice that won't make you gain weight.

It's high in vitamin B as well as important minerals including calcium, iron, zinc, and potassium. This high nutritional value makes it a must-eat in a balanced diet.

100 grams of uncooked Little Millet provides:

Calories: 329

Protein: 7.7 grams

Fat: 4.7 grams

Carbohydrates: 67 grams

Fibre: 7.6 grams

9. Kodo Millet

Kodo millet is thought to have been domesticated 3,000 years ago in India. It can be found in tropical and sub-tropical climates.

The whole grain includes large levels of fibre and high protein content. It is a digestible millet that contains higher quantities of amino acid – lecithin (which helps in strengthening the nervous system). Kodo is high in B vitamins, including niacin, B6, and folic acid, and minerals such as calcium, iron, potassium, magnesium, and zinc.

When consumed regularly by postmenopausal women, it can help to alleviate cardiovascular problems such as excessive blood pressure and cholesterol levels.

100 grams of uncooked Kodo Millet provides:

Calories: 353

Protein: 8.3 grams

Fat: 1.4 grams

Carbohydrates: 65.9 grams

Fibre: 5.2 grams

10. Broomcorn Millet

Broomcorn, also called Chena, has a low glycemic index, which helps to keep blood sugar levels in check. It is a healthy option for diabetics to include in their regular diet.

Magnesium is abundant in this millet, which helps to regulate blood pressure and reduces the risk of strokes, heart attacks, and atherosclerosis. It is a good source of potassium, which acts as a vasodilator and helps to maintain low blood pressure.

Broomcorn contains a lot of fibre, which helps to decrease cholesterol. It also aids in the removal of bad cholesterol from the body and promotes the production of good cholesterol.

100 grams of uncooked Broomcorn provides:

Calories: 354

Protein: 12.5 grams

Fat: 1.1 grams

Carbohydrates: 70.4 grams

Fibre: 5.2 grams

Introduction to value-added millet products

Millet flour

Different types of millet flours include pearl millet (bajra), finger millet (ragi), and foxtail millet. Each type offers unique nutritional properties and culinary applications.

Milling millets into flour involves cleaning, dehusking, and grinding the grains. Millet flours are rich in protein, fiber, and minerals, making them a nutritious alternative to traditional flours.

Millet flours can be used in various cooking and baking applications, such as making rotis, dosas, or as a gluten-free substitute in bread and cake recipes, offering versatility in the kitchen.

Millet flakes

The production of millet flakes involves dehusking the grains, steaming them, and then passing them through rollers to create thin flakes.

Millet flakes are nutritionally beneficial due to their high fiber content, low glycemic index, and rich mineral profile, making them a healthy alternative to traditional cereal flakes.

Millet flakes can be used in breakfast dishes like muesli and granola or as a topping for yogurt and smoothie bowls, providing a nutritious and tasty addition to meals.

Millet pasta

Millet pasta is a gluten-free, nutrient-dense alternative to traditional wheat pasta, offering a healthier option for those with dietary restrictions or preferences.

Making millet pasta involves mixing millet flour with water and other ingredients to create a dough, which is then shaped into various pasta forms.

Millet pasta has a higher protein and fiber content than wheat pasta and can be used in a variety of pasta dishes, such as spaghetti, penne, and macaroni, while maintaining a similar texture and taste.

Millet-based snacks

Examples of millet-based snacks include energy bars, cookies, crackers, and savory snacks like puffed millet and millet chips, which cater to various taste preferences.

These snacks are nutritionally advantageous due to their high protein and fiber content, and they often lack artificial additives commonly found in traditional snack foods.

The market potential for millet-based snacks is growing as consumers seek healthier, sustainable food options that align with their values and nutritional goals.

Production of millet-based snacks, bakery products, and beverages

The market today is replete with over 150 different products made out of millets.

These include an entire range of ready-to-eat foods, pre-mixes, snacks and savouries, as well as beverages and bakery products.

Due to the fact that millets are a nutritious, gluten-free grain that have gained popularity in recent years as a healthier alternative to wheat and other grains. The market for millet-based products has been very welcoming.

Some of these products can be taken up for manufacturing by SHGs. The following could be the steps towards taking up production of millet-based snacks, bakery products, and beverages:

1. **Source Ingredients:** Once you have your recipes, you'll need to source high-quality millet flour, grains, and other ingredients. You could source from local farmers, online suppliers, or specialized stores that sell organic and gluten-free ingredients.
2. **Production:** Once you have your ingredients, you can start production. The production process will vary depending on the product you are making, but you'll likely need to mix and blend the ingredients, shape or cut them, and bake or fry them.
3. **Packaging and Distribution:** Once the products are made, you'll need to package them appropriately and distribute them to retailers or directly to customers. Make sure to adhere to local food safety regulations and labelling requirements.
4. **Marketing and Sales:** Finally, you'll need to market and sell your millet-based snacks, bakery products, and beverages. Use social media, online platforms, and other marketing strategies to reach your target audience and promote the benefits of your products. You could also participate in food fairs, exhibitions or collaborate with health and fitness influencers or bloggers.

Millet is a nutritious, gluten-free grain that has gained popularity in recent years as a healthier alternative to wheat and other grains. Millet-based snacks, bakery products, and beverages are a great way to introduce this grain to consumers and provide them with healthy, tasty options.

1. **Millet Porridge:** Millet porridge is a simple and comforting dish that can be made by boiling millet grains in water or milk until they are tender and creamy. It can be seasoned with salt, sugar, or spices, and served for breakfast or as a side dish.

2. **Millet Pilaf:** Millet pilaf is a savory dish that is made by sautéing onions and garlic in oil, adding millet grains, and toasting them until they are fragrant. Then, vegetable or chicken broth is added and the mixture is simmered until the liquid is absorbed and the grains are tender. It can be served as a side dish or as a vegetarian main course.
3. **Millet Bread:** Millet flour can be used to make gluten-free bread that is dense and flavorful. To make millet bread, mix millet flour with yeast, water, and a little sugar, and let it rise before baking it in the oven. It can be enjoyed fresh or toasted with butter or jam.
4. **Millet Pancakes:** Millet flour can also be used to make pancakes that are light and fluffy. Mix millet flour with eggs, milk, and baking powder, and cook the pancakes on a griddle or skillet. They can be served with maple syrup or fruit for a delicious breakfast.
5. **Millet Soup:** Millet grains can be added to soups and stews for added texture and nutrition. To make millet soup, simmer vegetables, herbs, and spices in broth, and add millet grains towards the end of the cooking time. It can be served hot or cold, depending on the recipe.

Module 4: Solar PV System

Module Overview:

- Introduction to Solar Energy
- Introduction to solar PV systems
- Components of a solar PV system
- Design, installation and operation of a solar PV system

Introduction to Solar Energy

Definition of Solar Energy

What is solar energy?

Solar energy is the radiant energy emitted by the sun, which can be harnessed and converted into electricity or heat to power homes, businesses, and agricultural operations.

How solar energy is a renewable and clean energy source?

Solar energy is considered renewable because it is continuously replenished by the sun and does not deplete natural resources. It is also clean because it does not produce harmful emissions or pollutants when converted into electricity or heat.

The sun as an abundant and free energy source

The sun is an abundant source of energy that is available worldwide, and unlike fossil fuels, it is free to access and use. This makes solar energy a viable and sustainable option for meeting our energy needs.

How Solar Energy is Generated

Brief overview of the sun's structure and nuclear fusion

The sun is a massive ball of gas composed primarily of hydrogen and helium. At its core, the sun undergoes nuclear fusion, a process that converts hydrogen into helium, releasing a tremendous amount of energy in the form of light and heat.

How sunlight reaches the Earth

Sunlight travels through space and reaches the Earth's surface as solar radiation. This radiation includes visible light, ultraviolet (UV) rays, and infrared (IR) rays, which can be harnessed for various applications.

Solar radiation and the different types of solar energy

Solar radiation can be categorized into direct, diffuse, and reflected radiation. These different types of radiation can be harnessed through various solar technologies, such as photovoltaic (PV) systems and solar thermal systems.

Introduction to the photovoltaic effect and solar cells

The photovoltaic effect is the process through which solar cells convert sunlight into electricity. Solar cells are made of semiconductor materials, like silicon, which absorb photons from sunlight and generate electron movement, creating an electrical current.

Solar thermal systems: how they generate heat?

Solar thermal systems capture and absorb sunlight to produce heat. This heat can be used for various applications, such as heating water or air, cooking, or generating steam to power turbines and produce electricity.

Importance of Solar Energy for Agriculture and Rural Development

Addressing energy needs and reducing dependence on fossil fuels

Solar energy helps farmers become more energy-independent by reducing their reliance on grid electricity and diesel generators. This reduces energy costs and minimizes exposure to volatile fuel prices.

- Reducing greenhouse gas emissions and combating climate change

Solar energy is a clean alternative to fossil fuels, producing no greenhouse gas emissions. By adopting solar energy, farmers can reduce their carbon footprint and contribute to mitigating climate change.

- Supporting irrigation, water pumping, greenhouse farming, poultry farming, and cold storage

Solar energy can power various agricultural operations, such as irrigation systems, water pumps, greenhouses, poultry farms, and cold storage facilities, improving productivity and efficiency.

- Enhancing income generation and employment opportunities in rural areas

Solar energy projects can create employment opportunities in rural areas, from installation and maintenance to manufacturing and distribution of solar equipment, contributing to local economies.

- Rural electrification and improving the quality of life

Solar energy can provide electricity to remote and off-grid areas, improving the quality of life for rural residents by enabling access to education, healthcare, and communication services.

Solar Energy in India: Potential and Current Scenario

India's vast solar energy potential

India is geographically situated in a region that receives abundant sunlight throughout the year, with an average of 300 sunny days. This translates to a solar energy potential of about 750 GW, making it an ideal location for harnessing solar power for various applications, including agriculture.

Government initiatives and policies promoting solar energy adoption

The Indian government has been actively promoting solar energy adoption through various initiatives, such as the National Solar Mission and state-specific solar policies. These initiatives include setting ambitious renewable energy targets, offering financial incentives and subsidies, and providing support for solar projects. The government's efforts have resulted in significant growth in India's solar energy sector.

Current solar energy generation capacity in India

As of 31st March 2023, India had an installed solar energy capacity of around 66.78 GW, making it one of the top solar energy producers globally. However, this capacity is still far from the country's potential, and continuous efforts are being made to expand solar installations across the nation, especially in the agricultural sector.

Success stories and future prospects for solar energy in Indian agriculture

There are numerous success stories of solar energy implementation in Indian agriculture, ranging from solar-powered irrigation systems to solar cold storage facilities. Solar-powered water pumps, for instance, have enabled farmers to irrigate their fields without relying on diesel generators or grid electricity. Solar-powered greenhouses have also allowed farmers to grow

crops year-round, increasing productivity and income. With the government's support and the declining cost of solar technology, the future prospects for solar energy in Indian agriculture are promising, and its adoption is expected to grow rapidly in the coming years.

Introduction to Solar PV Systems

Definition of Solar Photovoltaic (PV) Systems

Explanation of solar photovoltaic (PV) systems:

Solar photovoltaic (PV) systems are designed to capture sunlight and convert it into electricity using solar cells made from semiconductor materials. They provide a clean, renewable energy source that can be used for various applications.

How solar PV systems convert sunlight into electricity:

Solar PV systems use the photovoltaic effect, where solar cells generate an electric current when exposed to sunlight. This happens because the solar cells' semiconductor material absorbs photons, causing electrons to move and create a flow of electricity.

Applications of solar PV systems in agriculture and rural development:

Solar PV systems can be used in agriculture for various purposes, such as powering irrigation systems, water pumps, greenhouses, poultry farms, and cold storage facilities. They can also contribute to rural electrification and provide electricity for schools, health centers, and homes.

Components of a Solar PV System

Introduction to the main components of a solar PV system:

A solar PV system typically consists of solar panels, a charge controller, an inverter, a battery, and wiring and mounting systems.

a) Solar panels: Function and types:

Solar panels capture sunlight and convert it into electricity. They are made up of solar cells connected together. The main types of solar panels are monocrystalline, polycrystalline, and thin-film, each with different efficiencies, costs, and applications.

b) Charge controller: Role in regulating voltage and current, types:

The charge controller regulates the voltage and current coming from the solar panels to the battery, protecting the battery from overcharging or discharging. There are two main types of charge controllers: Pulse Width Modulation (PWM) and Maximum Power Point Tracking (MPPT), each with different efficiencies and costs.

c) Inverter: Converting DC to AC, types:

The inverter converts the direct current (DC) produced by solar panels into alternating current (AC) that can be used by appliances and equipment. Common types of inverters are central, string, and microinverters, each with different capacities, efficiencies, and costs.

d) Battery: Energy storage for off-grid and hybrid systems, types:

The battery stores excess energy produced by the solar panels for later use, especially in off-grid and hybrid systems. Batteries can be lead-acid, lithium-ion, or flow batteries, each with different storage capacities, lifespans, and costs.

e) Wiring and mounting system: Importance of proper installation and safety measures:

The wiring and mounting system connects all the components of the solar PV system and ensures the safe and efficient installation of the solar panels on rooftops or ground mounts.

How Solar PV Systems Work: Converting Sunlight into Electricity

The photovoltaic effect: How solar cells generate electricity from sunlight:

The photovoltaic effect is the process by which solar cells generate electricity when exposed to sunlight. This happens because the solar cells' semiconductor material absorbs photons, causing electrons to move and create a flow of electricity.

How solar panels are connected to create a solar array:

Solar panels are connected in series or parallel configurations to form a solar array, which increases the system's voltage or current, respectively, to match the required output.

The flow of electricity from solar panels to the charge controller, battery, and inverter:

Electricity flows from the solar panels to the charge controller, which regulates the voltage and current before sending it to the battery for storage. The inverter then converts the stored DC electricity into AC electricity for use in agricultural applications.

How the converted electricity is utilized in agricultural applications:

The converted AC electricity is used to power various agricultural equipment and processes, such as irrigation pumps, greenhouse climate control systems, poultry farms, and cold storage facilities.

Types of Solar PV Systems: Grid-tied, Off-grid, and Hybrid Systems

Grid-tied solar PV systems: Connected to the electrical grid, advantages and limitations:

Grid-tied solar PV systems are connected to the electrical grid, allowing excess electricity to be fed back into the grid for credits or compensation. They have lower installation costs and can utilize grid power when solar generation is low. However, they cannot provide electricity during grid outages and may require net metering agreements with utility companies.

Off-grid solar PV systems: Independent from the grid, benefits and challenges:

Off-grid solar PV systems are not connected to the electrical grid and rely solely on solar energy and battery storage. They can provide power in remote areas without grid access and are not affected by grid outages. However, they require larger battery storage and higher initial investment costs.

Hybrid solar PV systems: Combining grid-tied and off-grid features, advantages and considerations:

Hybrid solar PV systems combine the features of grid-tied and off-grid systems, allowing for grid connection and battery storage. They provide greater energy security and can supply power during grid outages. However, they have higher initial costs due to the addition of batteries and may require more complex installation and management.

Selecting the Right Solar PV System for Your Needs

Assessing your energy requirements and available resources:

Analyze your current and future energy needs, taking into account factors such as crop types, farming operations, and available sunlight hours.

Evaluating the benefits and limitations of each type of solar PV system:

Compare the advantages and limitations of grid-tied, off-grid, and hybrid systems to determine the most suitable option based on your energy needs, location, and grid access.

- Design, installation and operation of a solar PV system

Site assessment: factors to consider before installation

- Available space: Determine the area available for solar panel installation, taking into account the size of the solar array needed to meet your energy requirements.
- Shading: Identify any objects or structures that may cast shadows on the solar panels, such as trees or buildings, and consider potential shading issues throughout the day and year.
- Roof or ground conditions: Evaluate the structural integrity and suitability of the roof or ground for installing solar panels. Check for proper load-bearing capacity, roof age, and material compatibility for rooftop installations, or ground stability and drainage for ground-mounted systems.
- Proximity to the electrical grid: Assess the distance and accessibility to the electrical grid, especially for grid-tied systems, as this may impact installation costs and feasibility.

Solar panel orientation and tilt angle for optimal energy production

- **Orientation:** The optimal orientation for solar panels is typically south-facing in the northern hemisphere, which maximizes exposure to sunlight and energy production.

The exact azimuth angle may vary depending on your location and specific site conditions.

- **Tilt angle:** The ideal tilt angle for solar panels depends on your latitude, local climate, and seasonal variations in sunlight. Adjusting the tilt angle throughout the year can help optimize energy production, but a fixed tilt angle set to your latitude is generally a good starting point.

Selecting the right components and equipment

- **Solar panels:** Choose between monocrystalline, polycrystalline, or thin-film solar panels based on factors such as efficiency, cost, and space requirements. Monocrystalline panels are the most efficient but also the most expensive, while thin-film panels have lower efficiency but can be more flexible in terms of installation.
- **Charge controller:** Select a charge controller that can handle the voltage and current of your solar array. Choose between PWM (pulse-width modulation) or MPPT (maximum power point tracking) charge controllers, with MPPT being more efficient but also more expensive.
- **Inverter:** Pick an inverter that matches the total power output of your solar array and is compatible with your system's voltage. Consider central, string, or microinverters based on your system size, complexity, and shading conditions.
- **Battery:** For off-grid or hybrid systems, choose a battery type (lead-acid, lithium-ion, or flow battery) that meets your energy storage needs and budget. Consider factors such as capacity, lifespan, efficiency, and environmental impact.
- **Mounting system:** Select a mounting structure (rooftop or ground-mounted) that is compatible with your site conditions and solar panels. Ensure the mounting system is sturdy, secure, and designed to withstand local weather conditions, such as wind and snow loads.

Installation process: step-by-step guide

- **Install the mounting system :** Ensure that the mounting structure, either rooftop or ground-mounted, is securely attached to the designated installation site. Proper weight distribution and adherence to safety regulations are crucial to maintain the stability and longevity of the solar PV system.
- **Install solar panels :** Carefully place the solar panels on the mounting structure, taking into account the correct orientation and tilt angle for optimal sunlight exposure. Secure the panels using appropriate fasteners and hardware according to the manufacturer's guidelines to prevent damage or dislodging.
- **Install the charge controller and inverter :** Choose a well-ventilated, shaded, and easily accessible location for the charge controller and inverter, keeping them away from direct sunlight and moisture to prevent overheating or damage. Securely mount and connect these components according to the manufacturer's recommendations.
- **Connect solar panels, charge controller, battery, and inverter :** Wire the components together by following the manufacturer's guidelines and electrical safety regulations.

Ensure proper connections, grounding, and cable management to minimize potential hazards and ensure optimal system performance throughout its life.

- **Install additional components :** Depending on your system requirements, you may need to connect additional components like monitoring equipment, sensors, or safety devices. These components can enhance the performance and safety of your solar PV system, providing valuable data and alerts to help maintain its efficiency.
- **Test the system:** After completing the installation, perform a thorough inspection and test to ensure all components are functioning properly, connections are secure, and the system is generating electricity as expected. This step is crucial for identifying any issues or problems that need to be addressed before the system becomes fully operational.

Connecting the solar PV system to the electrical grid (for grid-tied systems)

- **Coordinate with the utility company :** Work closely with your local utility company to ensure proper interconnection of your solar PV system and compliance with local regulations and guidelines.
- **Install a bi-directional meter:** Set up a bi-directional meter to track both electricity generation and consumption. This meter enables the utility company to measure the net energy usage and credit any excess energy fed back into the grid.
- **Obtain necessary permits, inspections, and approvals:** Prior to connecting your solar PV system to the grid, secure all required permits, inspections, and approvals from local authorities and utility companies. This process may vary depending on your location and specific regulations.
- **Connect the system to the grid:** Once all permits, inspections, and approvals are obtained, connect the solar PV system to the electrical grid following the utility company's guidelines and safety precautions.

Module 5: Millet Processing Unit

Module Overview:

- Components of a Millet Processing unit
- Design and installation of a solar Millet Processing Unit
- Maintenance and troubleshooting of Millet Processing Unit
- Operational guidelines to run the Millet Processing Unit

Components of a Solar operated Millet Processing unit

A solar millet processing unit is a sustainable way to process millet using solar energy. The components of a solar millet processing unit may vary depending on the processing needs and capacity. Here are some of the basic components that are commonly used in a solar millet processing unit:

1. Solar panels: Solar panels are the primary component of the solar millet processing unit. They are used to generate electricity from sunlight that powers the millet processing equipment.

2. Charge controller: A charge controller is used to regulate the amount of electricity that is generated by the solar panels. It helps to prevent the batteries from overcharging or discharging.

3. Batteries: Batteries are used to store the electricity generated by the solar panels. They are used to power the millet processing equipment when there is no sunlight.

4. Inverter: An inverter is used to convert the DC power generated by the solar panels and stored in the batteries into AC power, which is used to power the millet processing equipment.

5. Millet processing equipment: The millet processing equipment can include de-hullers, cleaners, grinders, and polishers. They are powered by the solar energy stored in the batteries and converted by the inverter. The details of millet processing unit are as follows.

- **Aspirator with Grader / Mechanized Sieve / Shaker:** This component is used to remove impurities such as dust, stones, and other foreign materials from the millet. The millet is passed through the aspirator with a grader, mechanized sieve or shaker, which separates the impurities from the millet.
- **Destoner / density grader:** This component is used to remove stones and other heavy impurities from the millet. The millet is passed through the destoner, which uses the principle of density to separate the heavy impurities from the millet.
- **Dehusking / hulling machine:** This component is used to remove the outer husk of the millet. The millet is passed through the dehusking or hulling machine, which removes the outer layer and produces dehusked or hulled millet.
- **Essential accessories such as Metal wire brush and air blower:** These accessories are used to clean the dehusked or hulled millet. The metal wire brush is used to remove any remaining husk, and the air blower is used to blow away any dust or debris.
- **Set of test sieves:** This component is used to separate the millet into different sizes. The millet is passed through a set of test sieves, which separate the millet into different sizes based on the mesh size of the sieve.

- **Manual portable grader:** This component is used to grade the millet based on size. The millet is manually passed through the portable grader, which separates the millet into different sizes based on the size of the holes in the grader.
- **Weighing machine and volume measures:** These components are used to measure the quantity of millet produced. The millet is weighed using a weighing machine, and the volume of the millet is measured using volume measures.

Once the millet has been processed through these components, it can be converted into millet flour or malt. The dehusked or hulled millet is ground using a grinding machine to produce millet flour. To produce malt, the dehusked or hulled millet is soaked in water and allowed to germinate before being dried and roasted.

Here are some additional components that may be used in a millet processing unit, along with their individual uses and stepwise use of these machines for millet processing:

- **Polishing machine:** This component is used to polish the dehusked or hulled millet. The millet is passed through the polishing machine, which removes any remaining husk or impurities and gives the millet a shiny appearance.
- **Grinding machine:** This component is used to grind the dehusked or hulled millet into flour. The millet is passed through the grinding machine, which grinds the millet into a fine powder.
- **Soaking tank:** This component is used to soak the millet for producing malt. The dehusked or hulled millet is soaked in water in the soaking tank for a specific period to allow it to germinate.
- **Drying machine:** This component is used to dry the malted millet. After the millet has germinated in the soaking tank, it is passed through the drying machine, which dries the malted millet.
- **Roasting machine:** This component is used to roast the dried malted millet. The dried malted millet is passed through the roasting machine, which roasts the malted millet to produce malt.

Stepwise use of the components for millet processing:

- Aspirator with Grader / Mechanized Sieve / Shaker: The millet is first passed through the aspirator with grader, mechanized sieve or shaker to remove impurities.

- Destoner / density grader: The millet is then passed through the destoner to remove any stones or heavy impurities.
- Dehusking / hulling machine: The millet is then passed through the dehusking or hulling machine to remove the outer husk.
- Essential accessories such as metal wire brush and air blower: The dehusked or hulled millet is cleaned using a metal wire brush and air blower to remove any remaining husk or dust.
- Set of test sieves: The millet is then passed through a set of test sieves to separate it into different sizes.
- Manual portable grader: The millet is then manually passed through the portable grader to grade it based on size.
- Weighing machine and volume measures: The millet is weighed using a weighing machine, and the volume is measured using volume measures.
- Polishing machine: The dehusked or hulled millet is then passed through the polishing machine to remove any remaining husk or impurities.
- Grinding machine: The polished millet is then passed through the grinding machine to produce millet flour.
- Soaking tank: To produce malt, the dehusked or hulled millet is soaked in water in the soaking tank for a specific period to allow it to germinate.
- Drying machine: The malted millet is then passed through the drying machine to dry it.
- Roasting machine: The dried malted millet is then passed through the roasting machine to produce malt.

By using these components and following these steps, a millet processing unit can efficiently process millet into millet flour or malt.

6. Wiring and cabling: Wiring and cabling are used to connect the solar panels, charge controller, batteries, inverter, and millet processing equipment together.

7. Control panel: A control panel is used to monitor the performance of the solar millet processing unit. It can provide information about the amount of solar energy generated, the amount of energy stored in the batteries, and the status of the millet processing equipment.

Design and installation of a solar Millet Processing Unit

Setting up a small solar-operated millet processing unit with a capacity of 500-1000 kg/hour through a Farmer Producer Organization (FPO) can be a great way to promote sustainable agriculture and improve the livelihoods of farmers. Here are some guidelines to follow when setting up such a unit:

- 1. Conduct a feasibility study:** Before setting up the millet processing unit, it is important to conduct a feasibility study to determine the viability of the project. This study should include an analysis of the market demand for processed millet, as well as an assessment of the availability and cost of the necessary equipment and solar panel system.
- 2. Choose a suitable location:** The millet processing unit should be located in an area that is easily accessible to the farmers who are members of the FPO. Additionally, the location should be close to a source of water, as water is needed for some of the processing steps. The location should also be exposed to ample sunlight, as the solar panels will need to be exposed to sunlight to generate energy.
- 3. Choose the right equipment:** The equipment for the millet processing unit should be selected based on the processing needs of the FPO members. Some of the equipment that may be needed include de-hullers, cleaners, grinders, and polishers. It is important to choose equipment that can handle the desired processing capacity of 500-1000 kg/hour.
- 4. Choose the right solar panel system:** A solar panel system is needed to power the processing equipment. The size and type of solar panel system you need will depend on the power requirements of the equipment. It is recommended to choose a system that can provide enough energy to power the millet processing unit, as well as any other electrical needs in the area.
- 5. Install the equipment and solar panel system:** Once you have chosen the equipment and solar panel system, you can begin installing the equipment. It is

important to ensure that the equipment is installed correctly and securely, and that all electrical connections are made properly.

6. **Train FPO members on the use of the equipment:** It is important to provide training to FPO members on the use of the millet processing equipment. This will help ensure that the equipment is used properly and maintained correctly. Additionally, providing training will help FPO members learn how to process millet more efficiently, which can improve their yields and increase their income.
7. **Monitor and maintain the equipment:** Regular maintenance and monitoring are necessary to ensure that the millet processing unit operates smoothly. It is important to check the equipment regularly for any signs of wear or damage, and to replace any damaged parts as soon as possible. Additionally, the solar panels should be cleaned regularly to ensure they are functioning at their maximum capacity.

Along with above consideration the following criteria related to selection of location, floor plan, civil works and electrical connection should be kept in mind.

1. Selection of location and criteria for selection of location:

- The location should be easily accessible to raw materials (millet) and markets for selling processed products.
- The site should have good connectivity to roads or other modes of transportation.
- Adequate space should be available for installation of equipment, storage of raw materials and finished products, and for loading and unloading of materials.
- The site should have access to water and electricity.
- The location should have good ventilation to prevent the accumulation of dust during processing.

2. Indicative floor plan for machineries based on Time motion study

Time motion study:

- A time-motion study can help optimize the layout and flow of the processing line to reduce processing time and increase efficiency.
- The study should identify any bottlenecks or delays in the processing line and suggest ways to eliminate them.

- The study should also analyze the time taken for each task and suggest ways to reduce it, such as automation or simplification of tasks.

Aspirator with Grader / Mechanized Sieve / Shaker

- This machine should be placed at the beginning of the processing line to remove impurities and separate the millet into different sizes.

Destoner / density grader

- This machine should be placed after the aspirator to remove stones and other heavy impurities.

Dehusking / hulling machine

- This machine should be placed after the destoner to remove the outer husk of the millet.

Essential accessories such as Metal wire brush and air blower

- These accessories should be placed at the end of the processing line to clean the millet after dehusking or hulling.

Set of test sieves

- These sieves should be placed after the aspirator to further separate the millet into different sizes.

Manual portable grader

- This grader can be placed at different points in the processing line to manually grade the millet based on size.

Weighing machine and the volume measures

- These machines can be placed at the end of the processing line to weigh and measure the processed millet.

3. Guideline for laying the foundation of the equipment:

- The foundation should be leveled and compacted to ensure a stable base for the equipment.
- The foundation should be made of concrete with a thickness of at least 10 cm.
- Grouting should be done after placing the equipment on the foundation to ensure it is secured in place.
- The foundation should have proper drainage to prevent water accumulation.

4. Electric work including earthing cabling and safety measures:

- All equipment should be properly grounded to prevent electrical hazards.
- Electrical wiring and cabling should be done according to local electrical codes and regulations.
- Adequate safety measures such as fire extinguishers, first aid kits, and emergency exits should be installed.
- The electrical system should have adequate load capacity to support the equipment.
- Electrical connections should be properly labeled for easy identification and troubleshooting.

- **Maintenance and troubleshooting of Millet Processing Unit**

Preventive maintenance and troubleshooting of a solar-operated millet processing unit and its components are important to ensure smooth operation and to minimize downtime. Here are some general guidelines for each component:

I. Preventive Maintenance

- Regular inspection and maintenance of electrical and mechanical components
- Tightness of electric connections, protection against moisture ingress, dust removal, oiling and greasing of mechanical parts, vibration checking, alignment and tightness of belt
- Regular inspection and maintenance of dynamic components of the machine
- Cleaning of grader sieves after every batch of processing with steel wire brush and air blower
- Filling of cracks and holes in sieve to maintain sieving efficiency
- Regular oiling of movable machine parts and avoidance of rust formation in all sieves
- Regular inspection and replacement of deteriorated dynamic components

II. Troubleshooting

1. Aspirator with Grader / Mechanized Sieve / Shaker:

- Regular cleaning of the inside of the aspirator and exit vanes to prevent accumulation of bran and other decomposable materials
- Application of oil on the impeller shaft bearing with help of grease gun to avoid friction between the bearing and the shaft
- Removal of faceplate on the fan box of the aspirator for regular cleaning Check for proper alignment of the aspirator
- Regularly clean the sieves and grader
- Check for loose bolts and nuts
- Grease and oil the mechanical parts
- Check for proper functioning of the motor

2. Destoner / density grader:

- Regular inspection and filling of holes or gaps in destoner bed mesh to prevent materials from slipping through the bed and into the machine enclosure
- Regular cleaning of the enclosure at the end of each shift to remove working material and dust
- Regular inspection and tightening of bolts holding down the destoner bed mesh to the frame of the bed
- Regular inspection of moving components (drive belts, pulleys, eccentric drive, shafts, and fan) for fatigue and wear and tear Regularly check and clean the destoner to remove any debris or dust buildup.
- Inspect the belts, bearings, and motors for any wear and tear, and replace as needed.
- Check the density grader calibration and adjust if necessary.

3. Dehusking / hulling machine:

- Frequent checks on performance of impeller shaft due to high rotational speed
- Regular inspection of pulley on the impeller shaft to prevent increased heat and damage to the impeller shaft
- Regular application of oil on movable machine parts and avoidance of rust formation in the bed sieve
- Regular removal of faceplate on the fan box of the aspirator for cleaning
- Replacement of eroded rubber liner and impeller in the medium to long time frame Regularly inspect and clean the dehusking/hulling machine to remove any debris or dust buildup.
- Inspect the belts, bearings, and motors for any wear and tear, and replace as needed.
- Check the machine's settings and adjust if necessary to achieve the desired output.

4. Solar PV cells, modules, arrays, inverters, and plates:

- Regularly inspect the solar panels for any damage, such as cracks or discoloration, and replace as needed.
- Check the wiring and connections for any loose or corroded connections, and repair as needed.
- Inspect the inverters and plates for any damage or malfunction, and repair or replace as needed.
- Clean the solar panels regularly to ensure maximum efficiency.
- Check for any faults in the inverter
- Check for any loose connections in the electrical system
- Check for proper grounding and earthing

In addition to these specific guidelines, here are some general tips for preventive maintenance and troubleshooting:

- Create a maintenance schedule and stick to it.
- Train personnel on how to operate and maintain the equipment properly.
- Keep detailed records of maintenance and repairs.
- Immediately address any issues or malfunctions to prevent further damage or downtime.
- Regularly test and monitor the equipment to identify any potential issues before they become major problems.

Operational guidelines to run the Millet Processing Unit

Workplace safety is crucial for the well-being of employees and the overall productivity of the organization. Safety measures can be implemented through the use of protective equipment, proper training, and adherence to safety guidelines.

Importance of Workplace Safety:

- Reduces the risk of accidents and injuries: Proper safety measures can prevent workplace accidents and injuries, which not only protects employees but also reduces costs associated with worker compensation.
- Boosts employee morale: A safe work environment helps employees feel valued and supported, which can lead to increased job satisfaction and productivity.

- Compliance with regulations: Following safety regulations is essential for companies to comply with legal requirements and avoid fines and penalties.
- Protects company reputation: Workplace accidents can damage a company's reputation and lead to negative publicity, which can impact future business opportunities.

Here are some exhaustive Dos and Don'ts for workers who are exposed to mechanical and electrical systems and working in a solar-operated millet processing unit.

Dos:

- Wear appropriate personal protective equipment (PPE) such as safety glasses, gloves, hard hats, earplugs, dust masks/respirators, and full body suits to protect against mechanical, electrical and dust hazards.
- Follow safe work practices and procedures as per the training provided.
- Ensure that all machinery and equipment are operated in accordance with the manufacturer's instructions.
- Maintain a clean work environment by regularly cleaning the work area and machinery, and using appropriate dust control measures like ventilation, dust collectors, etc.
- Use lockout/tagout procedures when working on machinery to ensure that the power source is turned off and cannot be accidentally turned on.
- Report any unsafe conditions or incidents to the supervisor or safety officer immediately.
- Ensure that all movable mechanical parts of machinery are properly covered with guards to prevent accidental contact and injuries.
- Use electrical equipment and circuits only if you have received proper training and authorization. Follow proper electrical safety procedures while working on them.
- Ensure that all machinery is properly grounded with double earthing to prevent electrical hazards.
- Use proper lifting techniques and equipment to avoid back injuries while handling heavy machinery or parts.
- Attend safety training programs and meetings to keep up-to-date with new safety measures and procedures.

- Maintain good personal hygiene and cleanliness to avoid contamination of the product and to prevent the spread of disease.

Don'ts:

- Do not operate machinery or equipment that you have not been trained on or do not fully understand.
- Do not wear loose clothing or jewelry while working with machinery, as it can become caught and cause injury.
- Do not disable safety guards or devices on machinery, even temporarily.
- Do not work on electrical equipment or circuits without proper training and authorization.
- Do not touch or work on live electrical circuits or equipment without appropriate PPE and safety precautions in place.
- Do not use defective or damaged tools or equipment. Report any defects or damage to the supervisor or safety officer immediately.
- Do not eat, drink or smoke in the work area to prevent contamination of the product.
- Do not use compressed air to blow dust from machinery or clothing as it can cause dust to become airborne and cause respiratory problems.
- Do not use machinery or equipment that has not been properly maintained or repaired.
- Do not stack or store heavy objects or equipment unsafely.
- Do not overexert yourself while lifting or moving heavy objects or machinery.

In addition to the above, workers in a solar-operated millet processing unit should also be aware of the specific hazards associated with the processing of millet, such as exposure to dust and other airborne particles. Proper hygiene practices should also be followed to prevent the spread of contaminants and maintain a clean work environment.

Assessment of Quality before procurement

The quality of the grains strongly influences the quality of the output during processing. It is essential to ensure that the input millet grains are of good quality. There are five main parameters to be considered in this assessment: moisture level, average grain size and hardness,

uniformity of grain sizes, nature and share of Materials Other Than Grains (MOTGs), and presence and nature of mud balls.

1. Moisture Level

- Excess moisture can cause fungal growth, pest infestation, heating of grains, and drop hulling efficiency.
- All procured grains must be checked for excess moisture before storage.
- One can check the moisture level of grains in a sack by putting hands deep in the middle of the sack. When moisture is high, the temperature increases as the hand goes deeper.
- Another way to check the moisture level is by picking up a fistful of millet grains and holding it in a clenched fist for 15 seconds.
- Grains procured with excess moisture need to be dried for reducing the moisture level to the acceptable level (12%).

2. Average Grain Size and Hardiness

- Larger grains are better for processing as the size of the small millet rice kernel increases with the size of the grain.
- It is important that the kernel is hard and cracks when bitten or crushed.
- Rainfed grains are better than irrigated grains on cooking quality, aroma, and nutritional composition.
- One can determine if the crop was cultivated in rainfed or irrigated conditions by checking the grain hardness by biting a few grains.
- The size of grains can be checked using a magnifying glass to visually inspect multiple samples.

3. Uniformity of Grain Sizes

- Uniform sized grains are easier to hull than grains of varied sizes.
- Attention should be given during procurement to buy grain lots with almost uniform sized grains.
- Test sieves set can be used to identify the size distribution of the grains.

4. Nature and Share of Materials Other Than Grains (MOTGs)

- MOTGs such as sand, large pebbles, stones, and straw dramatically increase the cost of processing.
- Efforts need to be taken to procure grains with meagre presence of MOTGs.
- Weed seeds pose quite a challenge as they have similar size and densities as that of grains.
- Pre-cleaning with a portable manual grader will help in reducing the time of cleaning.

- To know the level of presence of MOTGs, take a reasonably large sample, say 10 kg of the grain, and subject the same to pre-cleaning operations.

5. Presence and Nature of Mud Balls

- Mud balls, one of the MOTGs, is a major concern in processing.
- The mud balls coming from grains cultivated in clay-rich black soils are particularly problematic.
- Presence of mud balls can cause damage to processing machines.
- Mud balls can be removed by standard processing techniques as they typically have a different size and density compared to the grain.
- It is important to take measures to reduce the presence of mud balls during procurement.

Conclusion

Ensuring the quality of small millet grains is crucial for obtaining good output during processing. The five parameters for quality assessment - moisture level, average grain size and hardness, uniformity of grain sizes, nature and share of Materials Other Than Grains (MOTGs), and presence and nature of mud balls - must be taken into consideration during procurement.

MODULE:6 Building FPO/FPCs Capacity Building

Module Overview:

- Identification of training needs of FPOs/FPCs
- Skill development of FPOs/FPCs in millet cultivation practices, value addition, and marketing
- Developing business plans for FPOs/FPCs

What are Farmer Producer Organisations or FPOs?

Farmer Producer Organizations (FPOs) are entities formed by farmers to collectively engage in agriculture-related activities such as production, marketing, processing, and distribution. They are essentially farmer-owned and farmer-controlled organizations that aim to improve the socio-economic status of small and marginal farmers by increasing their bargaining power and access to markets, credit, and technology.

FPOs are registered under various laws such as the Companies Act, the Cooperative Societies Act, or the Trusts Act, depending on their legal structure. They can operate in different forms such as cooperatives, companies, or trusts, and can engage in different activities such as crop production, livestock rearing, or fishery.

FPOs provide various benefits to farmers, including economies of scale in production and marketing, better access to inputs and technology, improved access to credit and insurance, and higher prices for their produce. They also facilitate the adoption of sustainable agricultural practices and provide training and extension services to farmers.

Identification of training needs of FPOs/FPCs

Training is one of the important methods for developing and enhancing the capacities of individuals to improve their performance. Training farmers to enhance their knowledge, skills, and practices is a major investment.

TNA is the primary step in training cycle management. ‘Training Needs Assessment’ is the method of determining if a training need exists and, if it does, what training is required to fill the gap. TNA seeks to accurately identify the current levels of knowledge, skills and practices existing in the target area through surveys, interview, observation, secondary data and/or workshop. The gap between the present status and the desired status may indicate problems that in turn can be translated into a training need. Training need refers to the gap between ‘what is’ and ‘what should be’ in terms of trainees’ knowledge, skills, attitude and behaviour in a given situation and time.

To identify their training needs, the following steps can be taken:

1. Assess the current skill level of FPOs/FPCs : A needs assessment involves evaluating the existing knowledge, skills, and attitudes of FPO/FPC members to determine what training is required. The assessment should cover areas such as management, marketing, financial management, leadership, and governance. This can be done through surveys, interviews, or focus group discussions.
2. Identify Key Areas: Based on the needs assessment, identify key areas where training is required. These may include technical skills related to farming, marketing, financial management, and governance.
3. Develop a Training Plan: The training plan should be implemented in a structured manner, with appropriate resources allocated for the training. The training plan should outline the training objectives, content, and methods to be used. The plan should be based on the identified needs and should take into account the learning preferences of FPO/FPC members.

4. **Deliver the Training:** Deliver the training using a combination of methods such as classroom sessions, field visits, demonstrations, and hands-on training. Ensure that the training is relevant, interactive, and engaging.
5. **Monitor and Evaluate:** Monitor the progress of FPO/FPC members after the training to assess the effectiveness of the training. This can be done through surveys, interviews, or focus group discussions.

Skill development of FPOs/FPCs in millet cultivation practices, value addition, and marketing

The FPOs/FPCs (Farmer Producer Organizations/Farmer Producer Companies) can benefit greatly from skill development in millet cultivation practices, value addition, and marketing. Here are some suggestions for skill development in each of these areas:

1. **Millet cultivation practices:**
 - Soil testing and nutrient management
 - Seed selection and treatment
 - Sowing methods and timing
 - Weed management
 - Pest and disease management
 - Irrigation and water management
 - Harvesting techniques and post-harvest management

FPOs/FPCs can organize training programs, workshops, and demonstrations by experts and experienced farmers in these areas. They can also learn from successful millet farmers in their area.

2. **Value addition:**
 - Cleaning and grading millets
 - Processing millets into flakes, flour, and other value-added products
 - Packaging and labeling
 - Developing new products and recipes using millets

FPOs/FPCs can learn about value addition through training programs, workshops, and by partnering with food processing companies or institutions that specialize in millet processing. They can also experiment with new products and recipes and seek feedback from customers.

3. **Marketing:**
 - Identifying potential markets for millets and millet-based products
 - Branding and packaging millets and millet-based products
 - Developing marketing strategies and campaigns
 - Building relationships with buyers and distributors

FPOs/FPCs can learn about marketing by attending training programs, workshops, and by working with marketing experts or consultants. They can also network with other FPOs/FPCs or food companies to identify potential markets and build relationships with buyers and distributors.

In addition, FPOs/FPCs can leverage digital platforms to showcase their products and reach a wider audience. They can also collaborate with other FPOs/FPCs or food companies to promote millet-based products collectively.

Overall, skill development in millet cultivation practices, value addition, and marketing can help FPOs/FPCs to produce high-quality millets, add value to their products, and market them effectively. This can lead to better income and livelihoods for farmers, while also promoting the consumption of nutritious and sustainable foods.

Developing business plans for FPOs/FPCs

Developing a business plan for Farmer Producer Organizations (FPOs) or Farmer Producer Companies (FPCs) is crucial for their success and sustainability. Here are some key steps to consider:

1. **Conduct a market analysis:** The first step in developing a business plan is to conduct a thorough analysis of the market. This includes identifying the demand for the products or services that the FPO/FPC will offer, the competition, and the pricing strategy.
2. **Define the products or services:** The next step is to define the products or services that the FPO/FPC will offer. This could include fresh produce, processed food products, or value-added products like spices, tea, or honey.
3. **Assess the resource requirements:** Once the products or services are defined, assess the resource requirements, including land, labor, inputs, and equipment. Determine the investment required and identify potential sources of financing.
4. **Develop a marketing strategy:** Based on the market analysis, define the marketing strategy. This includes identifying potential buyers, developing a distribution network, and defining pricing and promotion strategies.
5. **Identify key performance indicators (KPIs):** KPIs are important metrics that measure the success of the FPO/FPC. These could include sales growth, market share, customer satisfaction, or profitability.
6. **Define the organizational structure:** Define the organizational structure of the FPO/FPC, including the roles and responsibilities of the management team, staff, and board of directors.
7. **Develop a financial plan:** Develop a financial plan that includes the projected revenue and expenses, cash flow projections, and break-even analysis.
8. **Identify risks and mitigation strategies:** Identify potential risks and develop strategies to mitigate them. This could include risks related to weather, market fluctuations, or supply chain disruptions.

9. Review and revise the plan: Once the business plan is developed, it should be reviewed and revised regularly to ensure that it remains relevant and aligned with the changing market and organizational needs.

Overall, developing a robust business plan is critical for the success of FPOs/FPCs. It helps to align the organization's goals and objectives, identify potential risks and opportunities, and secure financing and resources for growth and expansion.

Module 7: Financial management and resource mobilization

Module Overview:

- Financial management for FPOs/FPCs
- Access to credit and government schemes

Financial management for FPOs/FPCs

Any organization, including Farmer Producer Organisations (FPOs) and Farmer Producer Companies (FPCs), must have a sound financial management system in place. For FPOs/FPCs, financial management is crucial for the following reasons:

Effective financial management aids FPOs/FPCs in making efficient use of their financial resources by preventing waste and directing funds toward initiatives that benefit both individual members and the organization as a whole.

Accurate financial reporting is necessary for FPOs/FPCs to meet regulatory requirements and show accountability to members and stakeholders. Good financial management ensures accurate and timely financial reporting.

Access to credit and funding is necessary for FPOs and FPCs to carry out their operations, and good financial management is essential to obtaining bank loans and investments.

Planning and budgeting: Financial management enables FPOs/FPCs to efficiently plan and distribute funds to projects that advance the mission and goals of the organization.

Risk management: Good financial management enables FPOs and FPCs to recognize and control financial risks such as unforeseen costs, income shortfalls, and changes in the state of the market.

Growth and sustainability: To ensure long-term success, financial stability, improved operations, and sustained performance, FPOs/FPCs must adopt sound financial management practices.

I. Budgeting and Financial Planning -

- Here are some methods for financial planning and budgeting for FPOs/FPCs as well as advice on controlling cash flow and forecasting:
- Create a budget: A budget is a financial strategy that describes your anticipated earnings and spending for a specific time period. Create a list of all revenue sources, such as membership dues, grants, and sales revenue, before creating a budget for FPOs/FPCs. Next, make a list of every expense, including payroll, operating, and capital outlays. Create a budget using this information to represent the organization's financial objectives and top priorities.
- Monitor spending: For efficient budgeting and financial planning, expenses must be regularly tracked. To make sure that actual spending match anticipated expenses, FPOs/FPCs should set up a system for tracking expenses and frequently examine financial reports.
- Forecasting cash flow is essential to ensure that FPOs and FPCs have enough money to pay bills and fulfil financial commitments. Start by predicting the amount of money anticipated to come in from different sources, such as sales income and grants, to forecast cash flow. Next, make an estimate of how much money will be spent, including debt repayment and expenses. Create a cash flow forecast based on this data to show the organization's anticipated inflows and outflows.

- Monitor spending: For efficient budgeting and financial planning, expenses must be regularly tracked. To make sure that actual spending match anticipated expenses, FPOs/FPCs should set up a system for tracking expenses and frequently examine financial reports.
- Manage cash flow: To ensure financial stability, FPOs and FPCs must manage cash flow effectively. Prioritise payments and expenses according to their priority and due dates to manage cash flow. Additionally, FPOs/FPCs ought to create a reserve fund to pay for unforeseen costs or revenue shortfalls.
- Monitor spending: For efficient budgeting and financial planning, expenses must be regularly tracked. To make sure that actual spending match anticipated expenses, FPOs/FPCs should set up a system for tracking expenses and frequently examine financial reports.
- Consult a professional: FPOs and FPCs might profit from expert guidance on financial planning and budgeting. Consider working with a financial advisor or accountant who has experience creating and implementing successful financial plans for nonprofit organisations.
- FPOs/FPCs may create efficient budgets, predict cash flow, and better manage their finances by putting these strategies and advice into practise. This can assist them in achieving their financial objectives and laying a solid basis for continued success and growth.
- Monitor spending: For efficient budgeting and financial planning, expenses must be regularly tracked. To make sure that actual spending match anticipated expenses, FPOs/FPCs should set up a system for tracking expenses and frequently examine financial reports.

FPOs and FPCs need abide by a number of basic accounting and financial reporting regulations. These consist of:

Using accrual accounting, which recognises income and expenses when they are incurred regardless of when the real cash is collected or paid, is recommended for FPOs and FPCs.

To maintain accurate and consistent financial reporting, FPOs/FPCs should consistently implement accounting procedures and rules from one period to the next.

Materiality: Rather than disclosing every little detail, FPOs/FPCs should concentrate on publishing information that is important and significant to stakeholders.

Full disclosure: FPOs/FPCs should make all financial information fully available, including any unforeseen circumstances or unknowns that might have an impact on the organization's financial condition.

Objectivity: To ensure that stakeholders can trust financial reports, they should be unbiased and objective.

The primary categories of financial transactions, such as revenue, expenses, assets, liabilities, and equity, should be identified by FPOs/FPCs before beginning to create a chart of accounts. Choose the subcategories within each category that best fit the organization's needs for financial reporting and its activities. Create a standardized chart of accounts by allocating a different account number to each category and subcategory.

Financial reporting for FPOs/FPCs includes financial statements as a crucial part. Three financial statements serve as the foundation:

A balance sheet lists the organization's assets, liabilities, and equity as of a particular date.

Income statement: An income statement lists the organization's revenues and outlays for a certain time period.

Statement of cash flow The organization's cash inflows and outflows are reported in a cash flow statement.

III. Risk Management and Financial Controls

For FPOs/FPCs, managing financial risks is a crucial component of financial management. Here are some procedures for controlling financial risks:

Determine the financial risks that the FPO/FPC are exposed to, such as credit risk, liquidity risk, interest rate risk, or market risk.

Determine which risks are the most important and need immediate attention by evaluating the possibility and potential impact of each financial risk.

Create and apply controls to reduce the risks that have been identified. FPOs/FPCs can control credit risk, for instance, by establishing credit limits for clients, doing credit checks, and keeping track of creditworthiness. By keeping a reserve fund, keeping an eye on cash flow, and diversifying their funding sources, they can control liquidity risk.

Monitoring and evaluating the effectiveness of the risk controls on a regular basis will help to ensure their continued efficacy.

FPOs/FPCs must manage financial risks as well as adhere to numerous regulatory obligations.

For FPOs/FPCs, some compliance requirements include:

Registration: FPOs and FPCs are required to register under the Companies Act and abide by all rules that may be in force.

Accounting and financial reporting: FPOs/FPCs are required to keep comprehensive and accurate financial records as well as to create financial statements in compliance with accounting standards.

Tax compliance: FPOs and FPCs are required to abide by all applicable tax laws and rules, including timely filing of tax returns and payment of taxes.

legislative compliance: FPOs/FPCs are required to abide by additional legislative requirements, such as consumer protection, labour, and environmental regulations.

Governance and management: To maintain transparency, accountability, and regulatory compliance, FPOs/FPCs must have a defined governance structure and adhere to good management practices.

Access to credit and government schemes

Since it enables them to finance activities like buying seeds, fertiliser, and equipment, maintaining and upgrading their infrastructure, and managing unforeseen events like weather or market fluctuations, access to credit is crucial for farmers and agricultural operations. The following are some of the factors that make credit availability crucial for agricultural operations:

- Enhances productivity: Having access to loans enables farmers to invest in cutting-edge equipment and techniques that will boost yields, cut post-harvest losses, and raise the quality of their output.
- Increases income: Credit can assist farmers in increasing their operations, productivity, and, eventually, income.

Credit can assist farmers manage risks and deal with unforeseen circumstances, such as natural disasters or market swings, by acting as a safety net.

Access to loans can help farmers expand their businesses, diversify their crop portfolios, and look into new markets.

Recognising the Various Forms of Credit Available to Farmers

- Short-term loans referred known as "crop loans" are intended to cover costs associated with growing crops, such as the cost of labour, seeds, fertiliser, and pesticides.
- Loans for farm mechanisation include those for tractors, harvesters, and irrigation systems, among other agricultural machinery and equipment.
- Loans for land development: These are loans for grading, drilling wells, and other tasks that increase a piece of land's production.
- Loans for dairy and poultry farming include those for purchasing cattle, constructing sheds, and other infrastructure.
- Loans for rural housing are available to build or renovate homes for farmers.

Credit Eligibility Requirements and the Credit Application Process Varying lenders have different credit requirements and credit application processes. However, the following are some typical requirements:

- The applicant must be a farmer or someone who works in agriculture.
- A valid identity document such as an Aadhaar card, voter ID card, or passport is required of the applicant. A land title or lease agreement in the applicant's name is required. The candidate must maintain a bank account

Farmers can approach banks, cooperatives, or microfinance organisations to request credit. They must submit an application form together with the necessary paperwork, including an identity document, a land title, and bank account information. Depending on the loan size and type of credit, the lender may evaluate the applicant's creditworthiness through a credit evaluation and may demand collateral.

Making an application for government programmes to assist agricultural operations:

The Indian government has introduced a number of programmes to aid agricultural endeavours and offer farmers financing at discounted rates. Several of the common schemes include:

- The Pradhan Mantri Fasal Bima Yojana is a crop insurance programme that offers farmers financial assistance in the event that their crops fail due to natural disasters, pests, or illnesses.
- A credit card programme called the "Kisan Credit Card" offers farmers short-term finance for crop production, marketing, and other agricultural endeavours.
- The Pradhan Mantri Krishi Sinchai Yojana is an irrigation programme with the dual objectives of expanding the area under irrigation and enhancing water usage effectiveness.
- Rashtriya Krishi Vikas Yojana: This programme offers funding assistance for agricultural development initiatives like farm mechanisation, managing soil health, and crop diversification.

Types of Credit:-

For people, companies, and organisations, a variety of credit options are available, including:

- Personal loans: These are loans that people can take out to cover their own costs, such as house improvements, schooling, or medical expenses. Depending on the lender, personal loans have different qualifying requirements and application procedures, but they often involve a credit check and verification of income.
- Business loans are available for a range of needs, including the acquisition of equipment, the expansion of operations, or the hiring of personnel. Depending on the lender, the eligibility requirements and application procedure for business loans might vary, but they often call for a credit check and evidence of the business's income.
- People and corporations can use credit cards as lines of credit to make purchases. Depending on the issuer, credit checks are often required as part of the eligibility requirements and application processes for credit cards.
- Small loans known as microloans are frequently given to people or start-up companies in developing nations who do not have access to traditional banking services. Depending on the lender, different microfinance loans have different requirements and applications.

There are various credit options available for FPOs/FPCs, including:

- Bank loans: Banks and other financial institutions accept loan applications from FPOs and FPCs. The requirements for qualifying and the application process differ depending on the lender, but often involve a credit check and evidence of income.
- Government programmes: In many nations, government programmes offer financing to FPOs/FPCs at discounted rates. Depending on the plan, different requirements and application procedures must be followed.
- Microfinance Institutions: FPOs/FPCs can also apply for loans from organisations that focus on giving credit to startups and small companies. The requirements for eligibility and the application procedure differ based on the lender.

Before submitting a credit application, FPOs/FPCs should investigate the various credit options available to them and decide which ones best suit their needs. After that, they should compile the required paperwork and complete the application forms for the chosen lenders. Before signing any documents, it's crucial to have a firm grasp of the loan's terms and circumstances.

Financial institutions are critical to the provision of credit to farmers because they make it easier for farmers to obtain the financing they need to buy the inputs, machinery, and other necessities for their agricultural operations. The following are a few ways that financial institutions lend to farmers:

- Loans: Lending organisations lend money to farmers so they may buy inputs like seeds, fertiliser, pesticides, and farm equipment. Additionally, they offer loans for farm-related expenses like buying livestock, land, and other things.
- Credit cards: A number of financial organisations offer credit cards that farmers can use to buy inputs and other products for their farms. In comparison to conventional credit cards, these cards typically have lower interest rates.
- Microfinance: Farmers who might not be eligible for typical bank loans might get small loans from microfinance organizations. These loans typically have low amounts and short repayment periods.

For farmers who require finance, establishing a relationship with financial institutions is crucial. Following are some pointers for doing that:

Determine prospective lenders: Find out which financial institutions lend to farmers. Take into account the loans' interest rates, payback schedules, and other stipulations.

Create a credit history: Before approving a loan, financial organizations will look at a farmer's credit history. It's critical to establish a solid credit history by making on-time payments on debts and avoiding defaults.

Attend workshops on financial literacy: Many financial institutions provide workshops for farmers on financial literacy. Learn about loan applications, credit ratings, and loan repayment by attending these workshops.

Depending on the financial institution, the loan documentation and payout process may be different. Here are some standard procedures, though:

- **Application:** The farmer fills out and files a loan application to the lending company.
- **Verification:** The financial institution confirms the farmer's income and credit history.
- **Collateral:** To secure the loan, the farmer offers collateral, such as property, equipment, or cattle.
- **Disbursement:** After the loan is authorized, the lending company gives the farmer the money.
- **Repayment:** Up until the loan is entirely repaid, the farmer pays periodical loan payments to the lending company, which include both interest and principal.

- **Government Schemes**

In India, farmers have access to a number of government programmes designed to help them increase the productivity of their crops, increase their income, and ensure their social security. An overview of some of the programmes accessible to farmers is provided below:

- **PMFBY: Pradhan Mantri Fasal Bima Yojana** This programme intends to give farmers insurance protection for crop losses brought on by tragedies of the natural world and other causes.
- **Pradhan Mantri Kisan Samman Nidhi (PM-KISAN):** This programme intends to give small and marginal farmers direct income support by offering them cash assistance of Rs. 6,000 per year.
- **Soil Health Card Programme:** This programme gives farmers soil health cards to better their understanding of the nutrient state of their soil and their ability to plan crops.
- **The Paramparagat Krishi Vikas Yojana (PKVY)** is a programme that attempts to encourage organic farming by giving farmers financial support to adopt organic agricultural methods.
- **The Kisan financing Card Programme:** This programme offers farmers financing options to suit their agricultural needs.

Farmers must meet specific requirements, such as owning agricultural property, residing in India, and having a bank account, in order to be eligible for these programmes. Depending on the scheme, the application procedure differs. While some programmes only accept applications submitted online, others may require farmers to go to their local bank or agriculture department.

There are programmes available for Farmer Producer Organisations (FPOs) and Farmer Producer Companies (FPCs) in addition to programmes for farmers. These are referred to as Farmer Producer Organisations (FPOs) collectively. The following are a few of the FPO/FPC scheme options:

- **Agriculture Infrastructure Fund:** This programme offers financial assistance to FPOs for the construction of post-harvest and farm-gate infrastructure.

- Rashtriya Krishi Vikas Yojana (RKVY): This programme offers financial support for the development of infrastructure and FPO capability.
- The Pradhan Mantri Kisan Sampada Yojana (PMKSY) is a programme that aims to support FPOs as well as modernise and develop the agri-food processing industry.

FPOs/FPCs must be registered under the Companies Act or any other applicable act in order to be eligible for these programmes. A project proposal must be submitted to the appropriate government department or agency as part of the application process for these programs, and it will be considered based on a number of factors, including its viability and sustainability.

MODULE 8 Gender Mainstreaming and Social Inclusivity

Module Overview:

This training module has two units and each of them is comprised of a number of sessions, each dealing with a specific topic in gender mainstreaming and social inclusivity in millet value chain.

The two units are as follows:

- Unit 1: Importance of gender mainstreaming in millet farming and value addition
- Unit 2: Promoting social inclusivity in millet farming

It is expected that this training module would help reflect on gender bias and gaps in extension, and on potential tools and approaches to design and deliver gender-responsive EAS.

Importance of gender mainstreaming in millet farming and value addition

What is gender mainstreaming?

Gender mainstreaming is the process of ensuring that the different needs, interests, and priorities of women, men, and gender-diverse individuals are recognized and addressed in policies, programs, and practices.

In the context of millet farming and value addition, gender mainstreaming is important for several reasons:

1. Women's role in millet farming:

Millet farming has been an important aspect of agriculture in Karnataka, and women have played a significant role in it. Millets such as ragi, jowar, and bajra have been traditionally grown in the state and are important sources of nutrition for the local population.

In Karnataka, women have been involved in various aspects of millet farming, such as seed selection, sowing, weeding, harvesting, and post-harvest processing. They also play a vital role in the preservation of traditional seed varieties and knowledge transfer to future generations.

However, their contributions are often overlooked or undervalued. Gender mainstreaming can help to recognize and address the specific needs and challenges that women face in millet farming, such as limited access to land, credit, and agricultural inputs.

2. Gender and value addition:

Gender also plays a crucial role in the value addition process. Women are involved in different aspects of millet value addition, including cleaning, dehulling, milling, sieving, and packaging. They also add value to millets by preparing different products such as flour, porridge, cakes, bread, and snacks.

Women's involvement in millet value addition provides them with economic opportunities and income. It also promotes food security and nutrition, as millet-based products are nutritious and affordable. Women's participation in the millet value chain also supports the local economy by creating employment opportunities and promoting local food systems.

However, they face barriers in accessing markets, technology, and finance. Gender mainstreaming can help to ensure that the value addition process benefits both men and women and promotes gender equality.

3. Improved productivity and profitability:

Gender mainstreaming can also improve the productivity and profitability of millet farming and value addition. By recognizing and addressing the specific needs and challenges of women, farmers can better utilize their skills and knowledge, which can lead to increased productivity and higher quality products. In addition, promoting gender equality in the value chain can increase the participation of women in higher-value activities and improve the overall profitability of the sector.

4. Sustainable development:

To ensure that sustainable development initiatives are gender-sensitive and promote gender equality, gender mainstreaming should be integrated throughout the policy-making process, from planning to implementation and evaluation. This means analyzing the different needs and priorities of women and men, ensuring equal participation and representation of both genders in decision-making processes, and designing interventions that address gender disparities and promote women's empowerment.

It can also help to reduce gender disparities and promote social and economic development, which are critical for achieving the United Nations Sustainable Development Goals (SDGs).

In summary, gender mainstreaming is crucial for promoting gender equality and sustainable development in millet farming and value addition. By recognizing and addressing the specific needs and challenges of women, the sector can become more productive, profitable, and equitable for all.

Promoting social inclusivity in millet farming

This step can involve several strategies,

1. **Encouraging participation of marginalized groups:** It is essential to promote the inclusion of marginalized groups such as women, youth, and people with disabilities in millet farming. This can be achieved by providing them with training, education, and access to resources such as land, credit, and inputs.
2. **Empowering smallholder farmers:** Smallholder farmers often face many challenges that limit their ability to produce enough food and generate income from their crops. By empowering them through access to markets, information, and technology, they can increase their productivity and income.

3. **Promoting gender equity:** Women play a significant role in millet farming, yet they often have limited access to resources, information, and decision-making power. Promoting gender equity can involve measures such as providing women with training and education, increasing their access to land and credit, and involving them in decision-making processes.
4. **Supporting community-based organizations:** Community-based organizations such as cooperatives and farmer groups can play a critical role in promoting social inclusivity in millet farming. These organizations can help farmers access markets, inputs, and credit, as well as provide training and education.
5. **Encouraging sustainable farming practices:** Promoting sustainable farming practices can help improve the quality and quantity of millet crops while protecting the environment. This can involve measures such as promoting conservation agriculture, encouraging the use of organic fertilizers, and promoting the use of drought-resistant millet varieties.

By implementing these strategies, it is possible to promote social inclusivity in millet farming, which can lead to improved livelihoods for smallholder farmers, increased food security, and sustainable agricultural practices.

The key activities which can be undertaken to fulfil the above strategies are:

1. The farm women commodity groups need to be channelized to better access training, extension, information, credit inputs, marketing and other services at all levels.
2. Specially focused capacity building programmes for women in agriculture need to be formulated to refine skills with appropriate technologies.
3. Ergonomically designed farm tools and machines should be developed and popularized which can reduce drudgery of farm women from production to post production stages.
4. Sensitization efforts are required at village level to make women's equal rights in decision making a social norm and this requires a change in attitude of male members.
5. Women have enormous traditional agriculture knowledge which needs to find appropriate place in the change process under the fluctuating bio- physical environment.
6. Ensuring access to food, health and improved health care is a basis requirement for creating a well nourished healthy people who form the human capital in agriculture.
7. Adoption of strategic approach involving gender awareness, more human and financial resources, reforms for gender integration at local level, institutional approach, sustainable involvement and economic empowerment is crucial for women to realize and harness their potential.
8. Creation of institutional framework to accommodate voice of women in policy and decision making is an effective option for collective action.

9. Efforts should be made to make women's work visible, freeing time and energy from women's budget for resting and learning and investing in social dialogue which can further facilitate women empowerment.
11. Extension programs should identify women as an integral part of their target audience and focus should be on promotion supply of women friendly tools and implements at village level.
12. Establishing technology resource centers in village's clusters are required for making technologies available to women on a custom hiring basis.
13. Home based, post-harvest production and marketing activities should be supported by providing market information, linking them with local/ distant traders, improving transportation and storage facilities, improving processing and packaging techniques and enhancing credit facilities.
14. Building the capacity of women farmers to understand markets financial literacy, negotiation skills, explore greater choice and new opportunities and collectives for ensuring benefits to them. This will facilitate wider economic and social empowerment.
15. There should be an explicit process to identify market opportunities for women producers to gain new roles and power in agricultural market chains. This requires engagement of different stakeholders in the value chain. Market development should be followed by institutional changes to aggregate small- scale production and increase access of women producers to the markets.
16. Development and application of methodology to generate evidences and database on multiple pathways for nutrition security, changing societal roles and norms and leveraging men's support and exploring the possibility of making ICT available to women to facilitate community monitoring need strong support from policy makers and planners.
17. Regular gender trainings, replication of best practices in extension systems, scaling up advocacy and create of a platform for knowledge sharing among R & D institutions would further promote gender equality.
18. It is important to track the changing gender issues and priorities in different social, economy, technological, agro- ecological and policy environments for better designing and targeting of interventions based on informed knowledge.
19. Local contexts including agriculture situation and gender issues should go into developing micro level and regional policies for food and nutritional security.

Module 9: Field Visits and experiential learning

Module Overview:

- Field visits to successful millet farming and processing units
- Experiential learning through hands-on activities and demonstrations
- Sharing of best practices and experiences

Field visits to successful millet farming and processing units

Field trips to productive millet farming and processing facilities can have a number of advantages, including:

- Learning best practices: You can find out about successful millet farming and processing operations' best practices for millet growing, harvesting, and processing by witnessing them in action. You can use this information to enhance the way you grow or process millet in your own operations.
- Opportunities for networking: Field trips can present chances to get in touch with other growers or processors in the sector, possibly resulting in partnerships, collaborations, or new business opportunities.
- Access to cutting-edge technology: During your tour, you can learn about cutting-edge technology or machinery that successful millet farming and processing units may be using. You may get inspiration from this to upgrade or improve your own operations.
- Understanding market demands: You can learn about the kinds of millet products that are in demand and how they are sold by visiting successful millet processing facilities. This might assist you in adjusting your production and marketing plans to match consumer demand.
- For farmers and processors wishing to enhance their operations, increase their knowledge, and develop their businesses, field trips to productive millet growing and processing units can be a useful educational experience.

Experiential learning through hands-on activities and demonstrations

People can learn about agriculture more effectively by engaging in hands-on activities and seeing demonstrations. This method enables participants to have hands-on experience and participate in practical activities, which can be a useful tool for improving their comprehension of the agricultural industry.

Farm visits are one efficient way to engage students in experiential learning in agriculture. This entails transporting people to farms so they may see agricultural practises in action and see first-hand how different agricultural practises affect crop output, soil health, and the sustainability of the environment. These trips can also be used to conduct hands-on workshops on topics like soil testing and crop management, giving visitors the chance to learn from seasoned farmers and industry professionals.

Another strategy is to set up training sessions and seminars that offer practical expertise in a range of agricultural activities, including seed selection, soil preparation, planting, irrigation, pest management, and harvest. These initiatives can be carried out in cooperation with academic institutions, agricultural organisations, and research facilities, which can offer knowledgeable direction and assistance.

Technology can also be utilised to support experiential learning in the agricultural sector. Without having to actually visit a farm, people can experience realistic agricultural practises through virtual reality (VR) simulations, for instance. These simulations can be used to educate people about difficult ideas and give them a secure, controlled environment in which to learn and experiment.

Generally speaking, teaching people about agriculture through practical activities and demonstrations can be successful. Individuals can get a deeper grasp of agricultural practises, acquire new skills, and improve their ability to meet the difficulties facing the agricultural industry today by gaining practical experience.

Sharing of best practices and experiences

Sharing best practices and experiences in millet cultivation and processing can be accomplished through field trips and experiential learning. Here are some suggestions for maximizing these activities:

In advance: Make sure you have a solid strategy in place before participating in experiential learning activities or traveling on a field trip. Preparing your questions or conversation points in advance will help you focus on the precise themes or regions you wish to examine.

Pick the best websites: Be on the lookout for well-run farms or processing facilities that have a solid reputation in the neighborhood. To determine the finest places to visit, consult with regional authorities or organizations.

Engage local farmers: Spend some time conversing with them and learning about their experiences. Ask them about their procedures, difficulties, and achievements. Respect them, keep an open mind, and attempt to absorb as much information as you can from them.

Note-taking and photography During your field trips or experiential learning activities, make notes of your observations and insights. To assist you remember significant details, take pictures or movies.

Describe your personal experiences: Never be reluctant to impart your personal wisdom and recommended methods to nearby farms. They might also gain from any knowledge or skills that you have to offer.

Make sure to **follow up with the farmers or organizations** you met with after your visit or educational activity. To create enduring relationships and partnerships, continue the conversation and offer any thoughts or recommendations you may have.

The sharing of best practices and experiences in millet cultivation and processing can generally be facilitated via field trips and experiential learning. You can learn from local farmers and impart your own wisdom to assist the community's practices and outcomes better by being ready, courteous, and active

Module 10: Policy Advocacy and Networking

Module Overview:

- Advocating for policy changes to support millet farming and value addition
- Networking with government agencies, research institutions, and private sector players
- Creating alliances and partnerships for collective action

What is the issue?

Millets are an important crop for India and have several advantages, including their ability to grow in diverse agro-climatic conditions, their resilience to climate change, and their nutritional benefits. However, the lack of demand for millets discourages farmers from cultivating them, leading to reduced production.

Processing of millets is a vital link between production and consumption as it improves their sensory and edible quality¹. Processing of the millets namely sorghum, pearl and finger millet, which don't have a hard indigestible husk, is easy as it needs minimum processing (cleaning and grading) after harvest². However, significant drudgery and time are involved in the processing of small millets namely little, proso, kodo, barnyard, foxtail and brown top millets, considering the hard indigestible husk layer. There are significant gaps in the availability of modern millet processing equipment in our country.

The key challenges in millet processing are:

1. Limited availability of processing machines: The custom hiring centers (CHC) are not able to provide standardized set of millet processing equipment to the farmers. It is reported that Standardization of sieve type and size is difficult due to variations in grains of the same type.
2. High rental cost associated with the millet processing machines: A study conducted among the farmers of Odisha reported that CHCs charge high rents for various processing machines. This limits their usage as farmers feel that it would increase the cost of production
3. Lack of customized sieves in the market: There are different varieties of grains and for that there is a need for customized sieves for dealing with different types of small millets and for all pre and post hulling operations. Lack of customized sieves reduces the efficiency of the equipment and quality of the output.⁶
4. Limited electricity supply in the villages: Irregular electricity supply in the villages is one of the key limitations pointed out by the farmers.
5. Lack of Technical expertise among the operators: Shortage of skilled operators who understand the grains and are trained in using the right machine is one of the major challenges in cleaning small millet grain with minimum bran loss.
6. Lack of innovation and technology: Most of the machines available in the market are not user friendly as it is difficult to clean the inside of the machine daily, as grit, dust, mud and broken grains accumulate inside the covered bed with motor. Overall the existing technology is not competitive enough to address the increased demand in the millet production.

Gaps in the availability of competitive millet processing equipment would limit the production, distribution and consumption of the millets, which could eventually shrink the whole ecosystem. It is vital to ensure the availability of advanced processing equipment to improve the quality of millet processing and for quality output. In addition, it should keep a right balance between processing and nutritional value unlike the existing large scale processing, that compromise on the nutritional output of the small millets by removing the bran layer completely.

Policy interventions to support millet processing:

- Invite investments in millet processing R&D from private sector
 - **Renewable energy** - Incentivize and promote innovations that promote use of renewable energy such as solar energy in processing which can bring sustainability, and address the issue of irregular electricity availability in villages. It will also considerably reduce the cost in long run.
 - **Decentralization of CHCs:** Strengthening of the small-scale processing units (Village level) and custom hiring centers with adequate technology to make the millet processing machines accessible to the farmers at an affordable cost.
 - **Standardization of existing techniques:** Establish defined standard operating procedure for each processing equipment available in the market to make them more user friendly, particularly for women who play a key role in production and processing of millets.
 - **Create an Innovation Ecosystem:** Efforts should be taken to establish collaboration among manufactures, research institutions, and end users to promote cross learning so that new innovation can be developed based on real-time requirements.
- **POLICY INTERVENTIONS IN MILLET VALUE ADDITION:**

One of the major barriers to increasing millet consumption is the limited availability of convenient and value-added products. The hard seed coat of millets makes them difficult to process and cook quickly, which can deter consumers from choosing them over more convenient options.

The demand for RTE/RTC millet products can have a positive impact on the income of small farmers through a crowding-in effect in the backward market linkages with the farming sector. This can happen because the increased demand for millets will lead to an increase in the price of millets, which will encourage small farmers to grow more millets, thereby increasing their incomes. Additionally, the highly nutritious nature of millets, along with the low glycemic index and high calcium and iron content, can have a positive impact on India's nutrition landscape.

The addition of milled millet flour (foxtail, barnyard, finger millets) to wheat flour can increase the protein, fat, and ash concentration while reducing the carbohydrate concentration, making it a nutrition-dense option for supplementary feeding programs. Since millets are largely grown in tribal areas and involve significant labor participation of women, local-level millet processing can play a substantial role in enhancing tribal incomes and providing economic opportunities to women farmers.

Overall, promoting the use of millets in India can have multiple benefits, including improving the nutrition landscape, boosting the income of small farmers, and empowering women.

To overcome these challenges, there is a need for investment in research and development to create new and innovative millet-based products that are easy to cook, have longer shelf life, and are more palatable to consumers. This can be achieved through public-private partnerships that bring together industry, government, and academia to promote the development and marketing of millet-based products.

What should policy makers do?

- Invite investments in millet processing R&D from the private sector
- Incentivize private sector participation in RTE/RTC segment
- Decentralize value added processing

Millets are a super-food that has immense potential to improve dietary diversity. It is a hardy crop that is drought- and pest-resistant, is a part of subsistence diet and still faces significant hurdles in its forward market linkage. Production regions and processing zones don't coincide in India, diverting consumption of value-added products to niche, urban markets. Postharvest processing is labor-intensive and often uses milling equipment meant for other grains, reducing grain recovery.

RTE/RTC processing techniques are available, but its gluten-free nature restricts the kind of products created using millets as a base. Identifying the right technology for RTE/RTC production is prohibitively priced. While the Government has a dedicated IIMR for research and enterprise incubation, most projects run on a pilot basis or with private sector partners in a subdued role. There is a need for the Ministry of Food Processing Industries to encourage mechanization and create a conducive environment for pivoting research & development efforts to the private sector, with government aid (need-basis), identifying RTE/RTC processing as part of the MSME sector for credit access, decentralizing processing units to production sites, and creating employment opportunities, especially for women.

Module 11: Sustainability and future prospects

Module Overview:

- Encouraging adoption of Solar DRE technologies for sustainable millet farming
- Future prospects and opportunities for millet farming and value addition

Encouraging adoption of Solar DRE technologies for sustainable millet farming

Agriculture must pay close attention to sustainability, especially in regions where traditional farming methods have contributed to soil erosion, water scarcity, and other environmental problems. Solar Distributed Renewable Energy (DRE) technologies have the potential to significantly advance sustainable millet cultivation in these areas.

Here are some potential outcomes and advantages of promoting the use of solar DRE technology for ethical millet farming:

- **Cost-effectiveness:** The cost of solar DRE technology is falling, and the price of solar panels, batteries, and other equipment is also going down quickly. Farmers can profit from affordable solar-powered irrigation systems and other equipment with the aid of

government subsidies and other incentives, reducing their dependency on fossil fuels and grid electricity.

- **Climate adaptability:** Millet is a drought-resistant crop, but it needs enough water to yield well. Even in regions with scant rainfall, solar-powered irrigation systems can give farmers a dependable source of water. Drip irrigation and solar-powered pumps can help preserve water, lowering the chance of crop failure during dry seasons.
- **Sustainability of the environment:** Compared to normal agricultural methods, using solar DRE technologies can considerably reduce greenhouse gas emissions and other environmental effects. Solar-powered millet farming can improve soil health, biodiversity, and ecosystem services by eliminating the need for fossil fuels and chemical fertilisers.
- **Productivity gains:** Solar-powered irrigation systems can boost agricultural yields, improving farmers' livelihoods and access to food. Solar-powered pumps can assist farmers in growing more crops by providing a dependable source of water, which will improve earnings and lessen poverty.
- **Increased adoption and awareness:** Farmers may become more aware of the potential advantages of sustainable agricultural practises if solar-powered millet cultivation is encouraged. Farmers can discover innovative strategies for boosting productivity while lessening negative environmental effects by promoting the usage of solar DRE technologies.

Benefits of Solar DRE technologies for millet farming

- **Increased yields:** For millet crops to grow and thrive, they need enough sunlight. Farmers can power irrigation systems and give their crops dependable, continuous lighting with solar DRE technologies, potentially increasing crop yields.
- **Reduced production expenses:** Solar DRE technologies can help millet producers drastically cut production costs. Farmers can use solar panels to create their own electricity, which is considerably more affordable and sustainable, rather than relying on grid power or pricey diesel engines.
- **Increased income:** Millet farmers can boost their earnings and produce more money by utilising solar DRE technologies to increase yields and cut production expenses.
- **Lowered carbon footprint:** Solar DRE technologies are a clean, long-lasting energy source that can aid in lowering the millet industry's carbon footprint. Solar DRE technology can aid in the development of a more ecologically friendly and sustainable farming system by lowering the dependency on fossil fuels.
- **Increased availability of clean energy:** Access to dependable electricity is sometimes restricted or nonexistent in rural areas. Millet farmers may produce their own clean and sustainable energy using solar DRE technologies, which can also be utilised to power

other appliances and equipment in their homes and villages. The general standard of living for farmers and their families may increase as a result.

Future prospects and opportunities for millet farming and value addition

Future growth and expansion of millet farming and value addition in Karnataka are highly likely. Millets are cereals with small grains that can withstand drought and are full of nutrients and health advantages. Millets' nutritional value and versatility in a variety of agro-climatic situations have led to a rise in attention in recent years.

- Support from the government: Through a number of policies and programmes, the Karnataka government has promoted millet farming and value addition. The "Millet Mission" was started by the state government to boost millets' production and consumption there. Additionally, the government offers subsidies to millet processing and cultivation businesses.
- Millets are increasingly in demand on both the domestic and global markets because of their nutritious benefits. Millets are suitable for those who are gluten intolerant because they are also gluten free. Farmers and business owners now have a chance to take advantage of this expanding market.
- Crops that can withstand drought: Millets can withstand drought and need less water than other crops like rice and wheat. Millet planting can help alleviate water shortages brought on by climate change in many areas.
- Millets can be processed to provide a number of products with additional value, including flour, flakes, and snacks. These goods can be purchased in the market for a greater price and have a longer shelf life. Entrepreneurs now have the chance to establish millet processing facilities and increase the crop's value.
- Millets are full in dietary fibre, vitamins, and minerals, which is good for your health. They don't contain gluten and have low glycemic loads and glycemic indices. As a result, millets are healthy for those who have diabetes, obesity, and other medical disorders. Farmers and business owners have a chance to serve this niche market as health advantages of millets become more widely known.

A family of small-seeded grasses known as millet has been grown as a main crop throughout much of the world for many years. Millets are a valuable crop in areas with scarce water resources because of their reputation for growing well in dry and arid environments. Due to their nutritional significance and the potential for millet farming to aid in food security and poverty eradication, millets have attracted increasing attention in recent years.

Millets are in high demand worldwide, and new market trends are emerging:

Millets are increasingly in demand on the international market because of their nutritional worth and health advantages. Millets are a great food for those with gluten sensitivity, diabetes, and other health conditions since they are low in glycemic index, high in fibre, and free of gluten.

Due to its rich nutrient content, which includes vitamins, minerals, and antioxidants, millets are also becoming more and more well-known as a superfood.

Millets are a rapidly growing market, with a 4.6% predicted compound annual growth rate from 2020 to 2025. The greatest market for millets is in the Asia-Pacific area, followed by Europe and North America. Millets are increasingly in demand for processed meals like snacks, cereals, and flatbreads in addition to their more conventional uses in things like porridge and flatbreads.

Millet farming technology developments and value addition

Modern agricultural technology has improved the productivity and sustainability of millet production. One such breakthrough is the creation of millet types resistant to drought through breeding programmes. These types make millet farming more adaptable to climate change since they use less water and are more adapted to the changing environment.

Utilising precision agriculture methods to optimise crop management practises, such as remote sensing and data analytics, is another development in technology. This entails tracking the moisture content of the soil, forecasting agricultural yields, and spotting insect and disease outbreaks.

Another area where technology has had a big impact is value addition. To generate a range of millet-based products, milling, extrusion, and roasting technologies have been developed. These products, which are increasingly being promoted to consumers who are health-conscious, include flours, breakfast cereals, snacks, and beverages.

Governmental programmes to encourage millet cultivation and value addition-

Governments all across the world are putting laws and programmes in place to support millet farming and value addition as they become more aware of its potential. For instance, the Millet Mission was established by the Indian government to encourage millet planting and processing. By 2025, the mission is to produce 7 million tonnes of millet and promote millet-based meals for better nutrition.

The International Year of Millet will take place in 2023, and the African Union has proclaimed this continent's year to be one of millet. A number of African governments, notably those in Nigeria, Ethiopia, and Burkina Faso, have also started programmes to encourage millet cultivation and processing.

Possibilities for millet farming and value addition as a means of enterprise and revenue generation:

Particularly in rural areas, millet farming and value addition present substantial prospects for entrepreneurship and revenue generation. Growing millets and selling them to processors or processing them themselves and selling value-added goods are two ways that farmers can diversify their sources of income. This may contribute to higher earnings and better quality of life. To meet the rising demand for millet-based cuisine, entrepreneurs can launch millet-based food enterprises including cafes, bakeries, and snack bars. These enterprises have the potential to create jobs and advance the local economy.

In addition to enhancing food security and eradicating poverty, millet cultivation and value addition present considerable prospects for business and revenue development. Future prospects for millet farming are bright thanks to the rising demand for millets and improvements in agricultural technology.

Global Demand for Millets

Small-seeded grasses known as millets have historically been produced and eaten in many parts of the world, particularly in Africa and Asia. They are renowned for their great nutritional value, tolerance to drought, and affordable production costs. Due to its numerous health advantages, including their high fibre content, low glycemic index, and gluten-free status, millets have grown in popularity in recent years.

A rising understanding of millets' health advantages and environmentally friendly production methods has led to an increase in the demand for millets on a global scale in recent years. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) estimates that by 2022, the worldwide millets market will be worth \$12.8 billion. The demand for millets is influenced by a number of factors.

The demand for processed millet products like flour, flakes, and snacks is one new development in the millet market. These ingredients are utilised in a range of recipes, such as bread, cereal, and desserts, and are becoming more and more well-liked as a healthy substitute for wheat-based items. Another trend is the resurgence of interest in millets and other traditional grains as a result of the increased interest in ancient grains and traditional meals.

Due to its high nutritional value, affordable production costs, and resistance to climate change, millets have the potential to become a staple crop in the future. They are a perfect crop for regions with scarce water resources because they can be cultivated in a range of agroecological zones and can tolerate drought. The demand for processed millet products like flour, flakes, and snacks is one new development in the millet market. These ingredients are utilised in a range of recipes, such as bread, cereal, and desserts, and are becoming more and more well-liked as a healthy substitute for wheat-based items. Another trend is the resurgence of interest in millets and other traditional grains as a result of the increased interest in ancient grains and traditional meals. Due to its high nutritional value, affordable production costs, and resistance to climate change, millets have the potential to become a staple crop in the future. They are a perfect crop for regions with scarce water resources because they can be cultivated in a range of agroecological zones and can tolerate drought.

Technological Advancements

The production, processing, and marketing of millet products have significantly improved as a result of technological developments in millet farming and value addition. Although millet farming has historically been done using traditional techniques, modern technological advancements have led to more effective and fruitful methods.

Precision agricultural tools like Geographic Information Systems (GIS), remote sensing, and Global Positioning Systems (GPS) have made it possible for millet farmers to more effectively analyse and manage their crops. With the use of these technologies, farmers can track and map the health of their crops, the fertility of the soil, and the availability of water, helping them to plan their planting and crop management strategies.

Modern processing methods like micronization, extrusion, and baking have produced a wide variety of avant-garde millet-based goods, adding value. Cereals for breakfast, pasta, bread, and snacks are some of these products.

The introduction of Solar Direct-Current (DC) Refrigeration and Electronics (DRE) technologies is one of the most important technological developments in millet cultivation and value addition. Through the use of these technologies, farmers can enhance the post-harvest handling of millet products by lowering spoilage and lengthening their shelf life. Solar-powered refrigeration equipment, drying systems, and milling machines are examples of solar DRE technologies.

Solar DRE technologies have a huge potential impact on millet growing and value addition. For instance, by keeping the grains cool and dry, lowering the risk of spoilage, and extending the product's shelf life, solar-powered refrigeration units can aid farmers in maintaining their harvest. Farmers may dry their millet crops more effectively and minimise moisture-related post-harvest losses by using solar-powered drying equipment. Farmers that use solar-powered milling equipment may process millet more effectively, saving money on labour and improving the quality of the finished product.

A few of the famous examples of the inventive millet-based goods and processing methods that are constantly being created include:

- Millet Pasta: To make this product, millet flour is substituted for wheat flour. It offers a higher nutritional value than regular pasta and is gluten-free.
- Breakfast cereals made from millet that may be eaten with milk or yoghurt and are prepared by combining millet flakes, nuts, and fruits.
- Millet flour is a gluten-free substitute for wheat flour in baking and is created by grinding millet grains into a fine powder.
- Popped millet is a pleasant and nutritious substitute for conventional snacks. It is prepared by popping millet grains like popcorn.

Government Initiatives

Due to the nutritional and financial advantages it provides, millet cultivation and value addition have been receiving more and more attention from the government in recent years. The following are a few government programmes to support millet farming and value addition:

NMSA, or the National Mission for Sustainable Agriculture As part of this programme, the government offers financial support to farmers that embrace sustainable and climate-resilient farming methods, such as millet cultivation.

The Paramparagat Krishi Vikas Yojana (PKVY) programme encourages organic farming, which includes millet growing, by offering financial support to farmers who use organic inputs including vermicompost, bio-fertilizers, and insecticides.

National Food Security Mission (NFSM): To help millet farmers enhance their output and productivity, the government offers financial support.

The Pradhan Mantri Fasal Bima Yojana (PMFBY) programme offers millet farmers financial assistance and insurance protection in the event that their crops fail or are destroyed by natural disasters.

Small Farmers Agribusiness Consortium (SFAC): The SFAC encourages millet processing and value addition by giving farmers and business owners financial help.

The main objectives of the policies and programmes for helping millet farmers and business owners are to boost millet production and productivity, encourage sustainable and organic farming methods, offer financial support for value addition and processing, and guarantee a fair price for millet farmers. These programmes and strategies are designed to develop a millets market that is viable and profitable.

The Millet Mission in Karnataka is one effective government programme for increasing millet farming and value addition. The goal of this effort is to boost millets' production and productivity while also encouraging organic and sustainable farming methods and giving farmers financial assistance for value-adding activities. This effort has greatly expanded the production of millets in Karnataka, and millet-based items, like as snacks and breakfast cereals, have also increased as a result.

The Telangana Millet Village Scheme is another great project. By promoting sustainable farming methods, offering funding for processing and value addition, and developing a market for millet-based products, this programme aims to make millets the main crop in 100 villages. As a result of this project, millets are now widely grown in the chosen communities, and millet-based goods are becoming more and more popular.

IV. Entrepreneurship and Income Generation-

Particularly in rural regions, millet farming and value addition have great potential for business and revenue production. Because millet has low input costs and is resistant to drought, it is a desirable crop for farmers. Millet is processed and packaged into a variety of goods, including

flour, porridge, and snacks, adding value and generating extra income for farmers and business owners.

Pearl Millet Farms in Kenya is an illustration of a flourishing millet-based enterprise. The company has been successful in providing rural communities with employment opportunities while producing and marketing a variety of millet-based goods, including flour, snacks, and baby food. Similar to this, the Millet Mama brand in India has been effective in promoting items made from millet and raising awareness of its health advantages.

The following are some tactics for encouraging entrepreneurship, income generation, and value addition in millet farming:

- Farmer education and assistance: Farmers can boost their output and raise their revenue by receiving education and assistance on millet cultivation, processing, and marketing.
- Facilitating access to finance: Facilitating access to financing is important for encouraging entrepreneurship. Farmers and business owners can invest in millet production and value addition by giving them loans or grants.
- Promoting market connections can help farmers and business owners find customers for their wares and boost their income.
- Developing infrastructure, including as storage, transportation, and processing facilities, can assist decrease post-harvest losses and raise the price of millet.
- Making people aware of the health benefits of millet: Making people aware of the health benefits of millet can assist improve demand for millet-based goods and consequently boost the revenue of farmers and business owners. In rural areas, millet farming and value addition hold enormous potential for fostering business and generating revenue.

We can develop a vibrant millet-based economy by offering support and training, facilitating access to capital, fostering connections across markets, investing in infrastructure, and raising knowledge of the millet's health advantages.