

WHEAT PRODUCTION AND PROCESSING BUSINESS

TRAINING COURSE FOR YOUTH AGRI-ENTREPRENEURS

Ethiopian Agricultural Transformation Institute



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OVERVIEW OF THE MODULE

The Wheat Production and Processing Module is a theory and exercises that enables youth to profit from growing wheat and generate employment opportunities throughout the value chain. It focuses on profitable wheat production, job creation, and income improvement.

The module covers various topics, including an introduction to wheat, effective use of agricultural inputs, soil and water management, optimal wheat cultivation methods, harvesting and storage techniques, value addition, and ensuring economic viability. Its structured approach enhances farmers' productivity, adaptation to market dynamics, and cultivates profit-oriented growth.

The module adheres to principles of structured learning, exercises, for practical application. It functions as an educational resource available for both offline and online platforms. This means that learners have the flexibility to access and utilize the modules through various mediums, such as hard copies or digital platforms. Assessments at the end of each section evaluate learners' understanding.

The Agriculture-focused Dignified Employment for Youth (ADEY) program is implemented by the Ethiopian Agricultural Transformation Institute in partnership with the Mastercard Foundation to enable 611,343 inclusive and dignified work opportunities for young women and men and support youth entrepreneurship, employability, and sustainable livelihoods in the agribusiness sector.

INTRODUCTION

Wheat is a crucial crop for global food security. It serves as a staple food for a significant portion of the world's populations, particularly in regions like Europe, North America, the Middle East, Africa and parts of Asia. Ensuring stable and sufficient wheat production is essential to meet the dietary needs of billions of people worldwide.

Wheat is a valuable source of nutrients. It contains carbohydrates, proteins, dietary fiber, vitamins (such as B vitamins), and minerals (including iron, magnesium, and zinc). Whole wheat products, which retain the bran and germ layers, are particularly rich in fiber and provide more nutrients compared to refined wheat products. Wheat is adaptable to different climates, ranging from temperate to sub-tropical/tropical, and can be grown in diverse soil types, although it generally thrives in well-drained, fertile soils. Adequate rainfall or irrigation is essential during the growing season, especially during critical stages like tillering, flowering and grain filling.

Wheat flour serves as a raw materials for products, including bread, pastries, biscuits, cakes, cereals, and snacks. Its grains can also be sprouted to produce wheatgrass, which is consumed for its nutritional benefits.

In addition to its high local and international demand, it has also the potential to diversify business opportunities along with its value chain, mainly through both primary and secondary value additions practices. For example, the crop can be a primary raw material for flour and pasta factories. Thus, it has a potential opportunity for youths to earn as potential income generation. In connection with this, the government's commitment to supporting the sector, combined with ongoing research and the resilience of Ethiopian farmers, contributes to the growth and sustainability of wheat production in the country, which good opportunity for youths to access arable land in lowland areas and supporting by providing basic inputs (e.g irrigation pump).

Target groups: The target beneficiaries of this module are youth agri-entrepreneurs and others, such as individual farmers, who are interested in running wheat production and processing business activities. The module basically helps the target groups as reference materials and can be valuable to help the beginners to engage in the business. The whole training module will take about 22 effective hours using proposed training methodologies as indicated below.

Training methods: brainstorming questions, interactive lecturing, group discussion, presentation, sharing success stories, learning questions, tips/take away messages and post assessment questions

Training materials needed: flip chart, LCD, marker, pen, notebook, wheat grain of different varieties (durum and bread wheat), sticky notes, materials (seeds, sample pesticides, sprayer, etc.) required for practical demonstrations

SECTION 1. WHEAT PRODUCTION

Overview: this section covers the basic information about types of wheat (bread and durum), wheat production, its ecological requirements, challenges and opportunities related to wheat value chain.



Learning Outcomes

At the end of this section trainees will be able to:

1. Describe the importance of wheat in global and county level
2. Types of wheat crops produced in Ethiopia and their ecological requirements
3. Describe the nutritional and income generation value wheat crop
4. Describe the types of wheat grown, suitable environment and challenges in wheat production



Learning question

1. What is a wheat crop?
2. Where it is grown?
3. Overview of wheat cultivation in general?
4. What are the primary uses of wheat crops?

Wheat is grown in various regions of Ethiopia, with the major wheat-producing areas located in the midlands to highlands. Recently, wheat is produced in lowland irrigated areas of Ethiopia. Some of the prominent wheat-growing regions include Oromia, Amhara, Tigray, Southern Nations, Nationalities, and Peoples' (SNNP) region, (now divided into central Ethiopia, and south Ethiopia) and parts of the Ethiopian Rift Valley (Afar and Somali regions).

The Ethiopian government recognizes the importance of wheat production and has implemented initiatives to support and promote the sector. These initiatives include the distribution of:

- Improved seeds, provision of extension services,
- Investment in irrigation infrastructure, and
- The establishment of market linkages to ensure fair prices for farmers.

Ethiopia cultivates two types of wheat: durum wheat and bread wheat:

- Bread wheat is extensively grown across various agro-ecologies, including regions with off-season irrigation practices.
- It is mainly used for bread making but it is also used for biscuits, and other minor products
- Durum wheat, with high diversity in the country, is traditionally grown on Vertisols in the central and northern highlands and mainly for pasta and macaroni food types.



Fig 1: Bread Wheat, and Durum Wheat

Challenges to wheat production which decreases the grain yield in Ethiopia include:

- Poor management practices, variations in skills and resources among farmers,
 - Low use of inputs (seeds, fertilizers, chemicals), low mechanizations, low storage facilities and processing knowledge)
- The impact of diseases such as yellow rust, stem rust, and septoria.



Post assessment questions

1. What are the main types of wheat cultivated in Ethiopia?
2. What are the major challenges faced in wheat production?
3. Describe the common uses of wheat for home consumption in Ethiopia.



Duration: 2 hours



Learning question

1. Do you know the suitable agro-ecologies for wheat production?
2. What is the yield determining inputs used on wheat production?
3. Where do you think the inputs be accessed?

SECTION 2. INPUT REQUIREMENT AND OPTIMUM CONDITIONS FOR WHEAT PRODUCTION

Overview: to achieve a higher wheat yield, optimal agro-ecological conditions and proper agricultural inputs are essential. The growth and productivity of wheat are influenced by factors such as altitude, temperature, rainfall, and soil conditions within suitable agro-ecologies. Utilizing improved varieties, high-quality seeds, optimum use of herbicides and fungicides, and recommended fertilizers rates and types further enhance productivity per unit area and leads to higher yields.



Learning Outcomes

At the end of this section trainees will be able to:

1. Describe the optimal environmental conditions needed to produce bread and durum wheat in Ethiopia.
2. Describe well, known the available improved wheat varieties and their suitable agro-ecologies, and seed sources.
3. Familiarize with types of fertilizer available and widely used in Wheat production.

2.1 CLIMATIC AND SOIL CONDITIONS REQUIREMENT FOR WHEAT PRODUCTION

AGROECOLOGICAL SUITABILITY/OPTIMUM	OPTIMUM CONDITIONS
	The most suitable agro-ecological zones of wheat fall between 1900 to 2700 masl. But with irrigation it can be grown < 1900 m
	Optimum of 15-25 °C
	The most suitable average annual rainfall of >800 mm with 600 mm well distributed during the growth period.
	Wheat grows best when the soil pH is between 6.0 and 7.5.
	- It is best adapted to fertile, well-drained silt loam and clay loam soils. - Fertile loamy black soil and soil with good water holding capacity is appropriate for wheat cultivation.

Table 1. The optimum agro-ecologies suitable for wheat production

2.2 IMPROVED WHEAT VARIETIES AND SEED SOURCE

2.2.1 RECOMMENDED AND AVAILABLE IMPROVED BREAD WHEAT AND DURUM WHEAT VARIETIES

To achieve higher wheat yields, it is important to select varieties that are both high-yielding and resistant to diseases. Depending on the location of your farm and the amount of rainfall it receives, different cultivars are recommended.

Bread wheat varieties

- For highland areas with sufficient rainfall, consider using the following BW varieties: Shaki, Kulumsa, Gutu, Melka,
- For Mid altitude adapted BW varieties include: Deka, Boru, Balcha, Adet-1, Liberty and Shorima.
- For Lowland rainfed adapted BW varieties include: Asgori, Dursa, Abay, Kingbird and Biftu.
- There are also regionally adapted or released BW varieties: in Western Oromia highlands and similar wheat-growing areas the recommended cultivars include: Laku and Liben varieties.
- For Guji low and mid altitude areas, the suitable wheat varieties are Adola-1 and Miju.
- For the Bale highlands and mid altitude areas, the recommended varieties are Boku, Hachalu, Gelan, Danbel, Mandoyu, Sinja, and Sanate.
- For regions like North Showa, Wolo, Gojam, and similar areas, the recommended wheat varieties are Imegwa, and Tsehay.
- By selecting the appropriate varieties based on the specific geographical conditions, farmers can optimize wheat production in these areas (see tables 1 and 2).

NO	VARIETY	YEAR OF RELEASE	TARGET AGRO-ECOLOGY	RELEASED UNDER
1	Asgori	2023	Lowland	Rain fed
2	Abay	2021	lowland	Rain fed
3	Deka	2018	lowland	Rain fed
4	Balcha	2019	Midland	Rain fed
5	Ga'ambo-2	2019	lowland	Irrigated
6	Fentale 1	2015	lowland	Irrigated
7	Fentale 2	2017	lowland	Irrigated
8	Amibara 2	2017	lowland	Irrigated
9	Dursa	2020	lowland	Rain fed

10	Alimeraw	2024	lowland	Irrigated
11	Kakaba	2010	Lowland	Rain fed
12	Shorima	2011	Midland	Rain fed
13	Kingbird	2015	Lowland	Rain fed
14	Biftu	2022	Rain fed	Kulumsa

Table 1. List of early to medium maturing bread wheat varieties for lowland to midland rainfed and irrigated areas

NO	VARIETY	YEAR OF RELEASE	RELEASED UNDER	SEED SOURCE
1	Kulumsa	2023	Rain fed	Kulumsa ARC
3	Shaki	2021	Rain fed	Kulumsa ARC
4	Boru	2018	Rain fed	Kulumsa ARC
5	Leku	2021	Rain fed	Bako ARC
6	Gelan	2019	Rain fed	Sinana ARC
7	Liben	2015	Rain fed	Bako ARC
8	Miju	2022	Rain fed	Bako ARC
9	Adola-1	2021	Rain fed	Bore ARC
10	Hachalu	2020	Rain fed	Sinana ARC
11	Bondena	2018	Rain fed	Areka ARC
12	Obora	2015	Rain fed	Sinana ARC
13	Sofumer	1999	Rain fed	Sinana ARC
14	Balcha	2019	Rain fed	Kulumsa ARC
15	Tay	2005	Rain fed	Adet ARC
16	Adet-1	2020	Rain fed	Adet ARC
17	Gutu	2024	Rain fed	Kulumsa ARC
18	Melka	2024	Rain fed	Kulumsa ARC

Table 2. List of medium maturing bread wheat varieties for highland areas

Durum wheat

SN	VARIETY NAME	YEAR OF RELEASE	ADAPTATION ZONE (ALTITUDE M.A.S.L)	SEED SOURCE
1	Mangudo	2012	1880-2700	DZARC/EIAR
2	Utuba	2015	1880-2700	DZARC/EIAR
3	Tesfaye	2016	1600-2800	DZARC/EIAR
4	Alemtena	2017	1500-2600	DZARC/EIAR
5	D2018 (Donmattew)	2018	1500-2750	DZARC/EIAR
6	ETCross21	2021	1800-3000	DZARC/EIAR
7	Seftu	2023	1800-2600	DZARC/EIAR
8	Dahab	2024	300-1500	Werer ARC/EIAR

9	Jihur	2024	1800-2000	DZARC/EIAR
10	Bulala	2018		SARC/OARI
11	Begna	2022	≥1800	SARC/OARI
13	Sofumer	1999	Rain fed	Sinana ARC
14	Balcha	2019	Rain fed	Kulumsa ARC
15	Tay	2005	Rain fed	Adet ARC
16	Adet-1	2020	Rain fed	Adet ARC
17	Gutu	2024	Rain fed	Kulumsa ARC
18	Melka	2024	Rain fed	Kulumsa ARC

Table 3. Durum wheat varieties for adapted to lowland to midland areas of Ethiopia

2.2.2 Source and attributes of quality seed

- The source and quality of seeds depend on the variety type, seed class with known sources (labeled with full information like high germination percentage; high purity and uniformity of seed size; low moisture content ~12%)
- High yield begins with good quality seed, it is therefore important to select well matured, plump & uniform seeds.
- Farmers should always buy seed from certified seed companies or use Quality declared seed usually produced by public and private Seed enterprises, Unions and Farmer groups (Community Seed Multipliers and Farmer producer clusters)

Selecting improved wheat varieties: Selecting the improved varieties has the following advantages compared to old or local cultivars.

- Resistance to disease and insects
- Tolerance to heat, soil salinity or frost
- Appropriate size, shape and ripening time
- Good adaptation to the environment
- Uniform in maturity and heading and easy to identify off types
- Amenable to use mechanization
- Higher yield, better quality and nutrient use efficiency

Attributes of quality bread and durum wheat seed

- Uniformity
- High germination rate > 85%
- Well dried to 12.5% moisture Content
- Purity 98%: Ensure all seeds are of the same variety
- Clean: not mixed with foreign matter like stones or

dirt, or other seeds

- Not damaged, broken, shriveled, moldy, or insect damaged
- Not rotten or discolored/ faded
- All non-conformity to the variety should not exceed 2%.

2.3 FERTILIZER TYPES AND RATES USED FOR WHEAT PRODUCTION

In many parts of our country, the commonly used synthetic fertilizers are NPS (Nitrogen, Phosphorus, and Sulfur) and Urea. When utilizing NPS fertilizer, it is advisable to consult area-specific fertilizer recommendations based on available blended fertilizers and soil fertility analysis results.

- NPS fertilizer is sown along with wheat crop/ at planting due to its long-lasting nature (phosphorus is immobilized in soil).
- The amount of NPS fertilizer applied to wheat crop varies according to local conditions.
- Urea is applied 1/3 at planting and the remaining 2/3 rd at tillering stage of wheat crop but the rate depends on specific area recommendation.
- Natural fertilizers play a crucial role in preserving the humus content in the soil, which cannot be easily replaced by artificial fertilizers.
- Therefore, it is highly beneficial to prepare compost, vermicompost, and bio slurry compost based on local conditions and apply them to the field two to three weeks before planting.
- Additionally, leaving crop residue in the field is important.
- While natural fertilizers alone may require higher quantities, it is recommended to combine them with synthetic fertilizers for optimal results.



Post assessment questions

- What is the ideal altitude, rainfall, and temperature conditions for growing wheat crops? In the three agroecology's?
- Why is it important to use improved seeds instead of local cultivars?
- What are the commonly used synthetic fertilizers for wheat production? And Natural fertilizers?



Key message

- To ensure successful farming, it is important to have a good understanding of your agro-ecologies and assess their suitability for specific crop varieties.
- It is equally crucial to be knowledgeable about the source and quality of the seeds you use, as this affects the vigor and optimal plant density.
- It is important to use full recommended packages for production wheat seeds/grains in order to strive for higher productivity

SECTION 3. IMPROVED AGRONOMIC PRACTICES FOR IMPROVED WHEAT PRODUCTION SYSTEMS

Improved agronomic production practices are essential for successfully growing wheat at the farm level. These practices encompass a range of steps, tools, and methods that are crucial to pay attention to, as they directly impact the overall benefits obtained from wheat production.

- This section focuses on key practices related to pre-planting and planting practices recommended packages for optimizing input usage and promoting sustainable production.
- By following these practices, farmers can enhance their wheat cultivation and achieve improved yields while ensuring long-term sustainability.



Learning questions

At the end of this session trainee will be able to:

- Understand and use pre-planting and planting recommended practices for both durum and bread wheat production.
- These include: Land preparation / tillage practices/cultivation practices; planting methods; fertilizer application methods, crop rotation etc.



Duration: 8 hours



Learning Questions

- What are the common land preparation methods used in your area?
- When do you consider the appropriate sowing window in your locality?
- Do you have any information about the types and rates of seeds and fertilizers used?

3.1 PRE-PLANTING PRACTICES

i) Site selection

Appropriate site with known land history should be selected. It is good to select legumes/oil crops and followed by wheat rotation systems. The land should have gentle slope for draining out the water and with good fertility status.

ii) Land preparation

Before wheat is grown, the soil should be prepared by ploughing, leveling and then manuring. This helps with proper aeration of the soil.

The purposes of land Preparation are:

- To create the best soil conditions that will encourage successful plant establishment,
- To control diseases and insect pest infestations
- To reduce weed competition for light and nutrients

- To Improve soil, water and air conditions
- for good plant growth and higher grain yield

The basic process of soil preparation is plowing and harrowing, which may involve:

- Manual implements
- Machines, or automated tools

There are two to three tillages for wheat crops.



Animal tractions secondary tillage

- **Primary tillage:** This initial step involves opening the soil, allowing for better aeration and encouraging the growth of beneficial microorganisms that enhance soil fertility.



Tractor ploughing primary tillage

- **Secondary plowing and rototilling:** The second stage of land preparation breaks the soil into smaller particles, creating a finer texture suitable for forming an ideal seedbed for wheat.



- **Rotary tilling:** further helps to even out the soil density, facilitating uniform seed placement.

The common practices for land preparation

- To prepare the land for wheat cultivation, follow these key steps: perform subtle cultivation after harvest considering rainfall and machinery, plow and harrow to establish a uniform seed bed, ensure weed-free seed bed by removing volunteers of the same crop, and plow across the slope on sloped areas.
- For irrigated wheat, provide pre-sowing irrigation, deep plow the soil during irrigation, and perform a light disking afterward. Additionally, level the seedbed for uniform stands and consider plowing in the direction of the slope.
- Don't plough the farm to the slop direction: as you plough your farm the slop direction, fertile soil removed, and the land will be out of farming



Tillage depth and plowing frequencies

A plowing depth in the range of 15 to 20 cm is generally sufficient and there is rarely an advantage to going deeper. Traditionally, most tillage operations consist of primary tillage followed by secondary tillage.

TILLAGE METHODS	TILLAGE TYPES			
	Primary tillage	2ndry tillage	Tertiary tillage	Tillage frequency
Animal drawn	15 to 20	10 to 15	10 to 15	3-4
Tractor mounted	20 to 30	15 to 20	-	2-3
Both tractor and animals drawn				3

Table 2. Tillage depth on tillage stages and plowing frequencies by methods

Time of land preparation

In Ethiopia, clearing and land preparation usually begins around April to May following the onset of rain fall, after a long dry season. Planting starts in June through July.

TRADITIONAL AGRO-ECOLOGIES	ALTITUDE (MASL)	ANNUAL RF (MM)	TIME OF LAND PREPARATION
Dry Kola	500-1500	<900	March to July
Moist Kola	500-1500	900-1400	March to July
Dry Weyena Dega	1500-2300	<900	Mar-July, example, A/Negele woreda
Moist Weyena Dega	1500-2300	900-1400	January to August in some parts of the country
Wet Weyena Dega	1500-2300	>1400	Mar-Nov, example, in Wonchi woreda; Mar- July in Horo & Werre Jarso woreda
Moist Dega	2300-3200	900-1400	Jan – Oct., example, Sinana woreda, Jan- July in Lay Gaint woreda
Wet Dega	2300-3200	>1400	Dec – Aug., example, in Semien-Ari woreda, Dec- Aug in Dabata woreda

Table 3. Timing of land preparation in different agro-ecologies of Ethiopia
Source: Desalegn, 2019

DO NOT BURN PLANT RESIDUES.

- As burning destroys plant nutrients from the residues and cannot easily be replaced.
- Dig the plant residues into the soil to improve soil fertility, aeration and water retention capacity



Drainage management practices

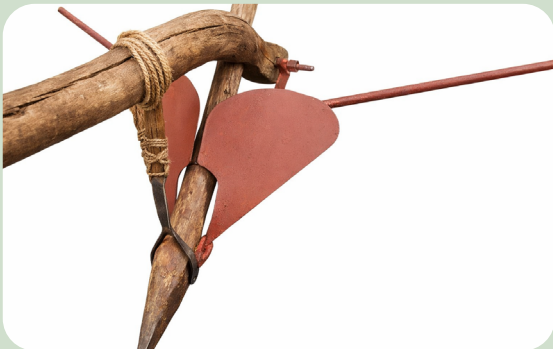
For wheat cultivation, it is important to have well-drained soils that allow water to infiltrate and drain effectively.

- Poor drainage can lead to waterlogging, which deprives the roots of oxygen and can result in root diseases and reduced crop productivity.
- There are various tools and methods developed for modification of soil surface to drain excess water.



BBM

The BBM (broad bed and furrow maker) is a tool developed for animal traction



Aybar

The Aybar BBM, manufactured by Aybar Engineering is the improved version and most popular



- Ridge and furrow can be prepared using the hands, although the practices can take time consuming
- The ridges may not be more than 30 cm high when freshly made and about 70-120 cm apart, depending on the availability of tools for preparation of seed beds.



The use of animal traction allows preparation of small ridges and furrows, though ridge and furrow system at 80 or 90 cm spacing is also possible.

Application of Manure

- Compost or animal manure should be added at rate of 2 to 4 tons per hectare during the first cultivation to allow for adequate decomposition and any weed seeds carried along to also germinate before the final tilling session prior to planting.
- The effects of organic nutrient sources are not immediate as inorganic nutrient sources, but their effects are long-lasting and sustainable.

The different sources of manure are described below:

- Cattle dung, urine, and slurry from biogas plants.
- Waste from human habitation such as human urine, sewage, domestic waste.
- Droppings of goats and sheep.
- Waste from the slaughterhouses, such as bones, meat, horn and hoof meal.
- By products of agricultural industries.
- Crop waste; weeds like water hyacinth.

Sowing Window

Sowing window of wheat depends on:

- Variety of the crops (early, medium and late maturity types)
- Altitude (elevation)
- Soil type
- On-set and distribution of rainfall
- The selected improved variety should be planted at the recommended sowing time

The predominant wheat sowing windows in Ethiopia are typically as follows:

- Late-maturity varieties need to be planted early relative to early-maturing varieties
- In the Ethiopian main season, wheat can be planted from June to end of July.
- In 'Belg' season, the harvest can be sowing from mid-February to early April
- In most Vertisols with improved drainage, wheat can be planted in the first half of July
- However, late sowing can result in crops not maturing before the end of rainy season and results in severe pest and disease infestations. Seeds of crops planted late can be shriveled and have low

viability due to terminal low moisture stress.

3.2 PLANTING PRACTICES

3.2.1 PLANTING METHODS AND SPACINGS

Wheat is planted with different sowing methods depending on:

- The available soil moisture
- Timing of sowing
- Availability of residues in the field
- Availability of the row planter

Broadcasting and row planting are the sowing methods most practiced in Ethiopia.

Row planting is done in two ways. Sowing by tractor mounted and behind local plow



Broadcasting wheat planting



Line sowing by hand drillings



Sowing by tractor mounted

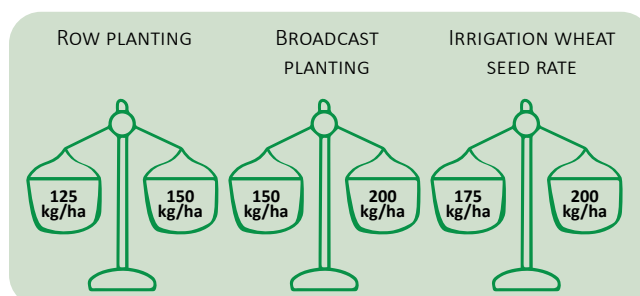
- Row seeding is the recommended method due to its even seed distribution at the desired depth, which usually results in higher germination and more even crops.
- Broadcast sowing not only requires a higher seed quantity, but also leads to a smaller crop population
- Row seeding facilitates effective crop protection measures, weeding operations and field inspections.
- Row spacing is 20 cm for mechanical seed drills and 20-25 cm for local plows

3.2.2 SEEDING RATE

- The seed rate is the most important management factor affecting the agronomic characteristics of wheat. Seeding rates can affect wheat tillering, grain yield, and wheat protein quality.
- At the highest seeding density, increased competition within plants may also have contributed to the decrease in plant height.
- Optimum seeding rates are therefore required to achieve higher agronomic performance and better end-use quality.
- However, for cultivars that produce less tillering, higher seeding rates compensated for reduced tillering and encouraged more main shoot tips.
- In dense population, grain yield decreased due to interplant competition that induced self-regulation.

The optimal seed rate/ha depends on:

- Type of variety or cultivar
- Tillering capacity
- 1000 seed weight
- Germination capacity
- Climatic conditions
- Soil type
- Sowing time
- Sowing method
- The area of production
- Soil moisture content of the areas



Sowing depth

- Seed should be placed in a moist zone for better germination and establishment,
- As a rule of thumb, the seeding depth should be about 5 times the size of the seed.
- The ideal seeding depth for wheat is generally from 2 to 3 cm



3.2.3 FERTILIZER RECOMMENDATIONS

The requirements for the optimal amount of fertilizer for wheat production vary from place to place due to several environmental factors. There are four main factors to consider when applying fertilizer to wheat. These are,

- Applying the right doses of different nutrients after considering the needs of the crop and the soil reserve supply.
- Applying these nutrients at the right time.
- Using the right application methods.
- Fertilizer applications can be most effective when applied when plants need it and can readily take it up.

Fertilizer rate

In Ethiopia, NPS, DAP and UREA are the only inorganic fertilizers that are dominantly used in different regions

SOIL TYPE	BREAD WHEAT		DURUM WHEAT	
	NPS/ Kg/ha	UREA Kg/ha	NPS Kg/ha	UREA Kg/ha
Vertisol 	150 ~ 200 	200-250	100-200	150-200
Clay 	100-150	150-200 	100-150	100-150
Light Sandy Soil 	100	100	100	140

Time of fertilizer application

- Full dose of P fertilizer as DAP or NPS should be applied at sowing.
- Apply N fertilizer in split doses as urea is a highly leaching fertilizer.
- The timing for N fertilizer applications is at or close to the period of rapid uptake.
- For bread wheat use 1/3 of the recommended Urea at planting and 2/3 after 21-24 days of wheat emergence. Apply only after weeds are suppressed.
- To maintain the quality of durum wheat, it is better to apply 1/4 of the recommended urea at planting, 1/2 at tillering and 1/4 at anthesis stage.
- Adequate soil moisture is required during fertilizer application.



Do not apply N fertilizer

- On waterlogged soils and when heavy rain is expected to come. Heavy rain can washout top-dressed fertilizer
- If water is unavailable, do not apply fertilizers as plants will not be able to absorb it.

3.2.4 INTEGRATED USE OF ORGANIC AND INORGANIC FERTILIZER

Recycling organic waste can be a viable option to utilize low rates of chemical fertilizers without causing nutrient depletion in the soil. However, sustainable wheat productivity cannot be achieved through inorganic fertilizers or organic sources alone. The optimal approach for soil fertility management is a combination of both inorganic and organic fertilizers, where the inorganic component provides necessary nutrients, and the organic component enhances soil organic matter, structure, and buffering capacity.

Notes need to be considered:

- The underlying principle of integrated nutrient management for wheat is to maintain and potentially improve long-term soil fertility for sustained wheat productivity while reducing fertilizer inputs.
- Application of organic manures increases the availability of native soil nutrients and enhances the efficiency of applied fertilizers.
- The optimal combination of organic and inorganic nutrient application requires determination based on soil type, crop species, and location.
- Compost releases nutrients slowly, and plants may not be able to access the required amount of nutrients during the critical yield-forming period.
- Relying solely on artificial fertilizers is not sufficient to maintain adequate nutrient levels in the soil.
- The increased cost of chemical fertilizers and higher demand for organic residues in the field necessitate the combined use of compost and inorganic fertilizers.
- Note that the application of half the recommended rate of NP fertilizer with 50% of the recommended compost (3t ha⁻¹) can be an alternative best integrated soil fertility management approach for both bread and durum wheat.

3.2.5 CROP ROTATION

Crop rotation is the practice of alternating different crops on the same field from year to year or a sequence of growing seasons. Growing the same crop in the same place for many years is known as mono-cropping. It gradually depletes the soil of certain nutrients and selects for a highly competitive pest and weed community.

Characteristics of good crop rotation

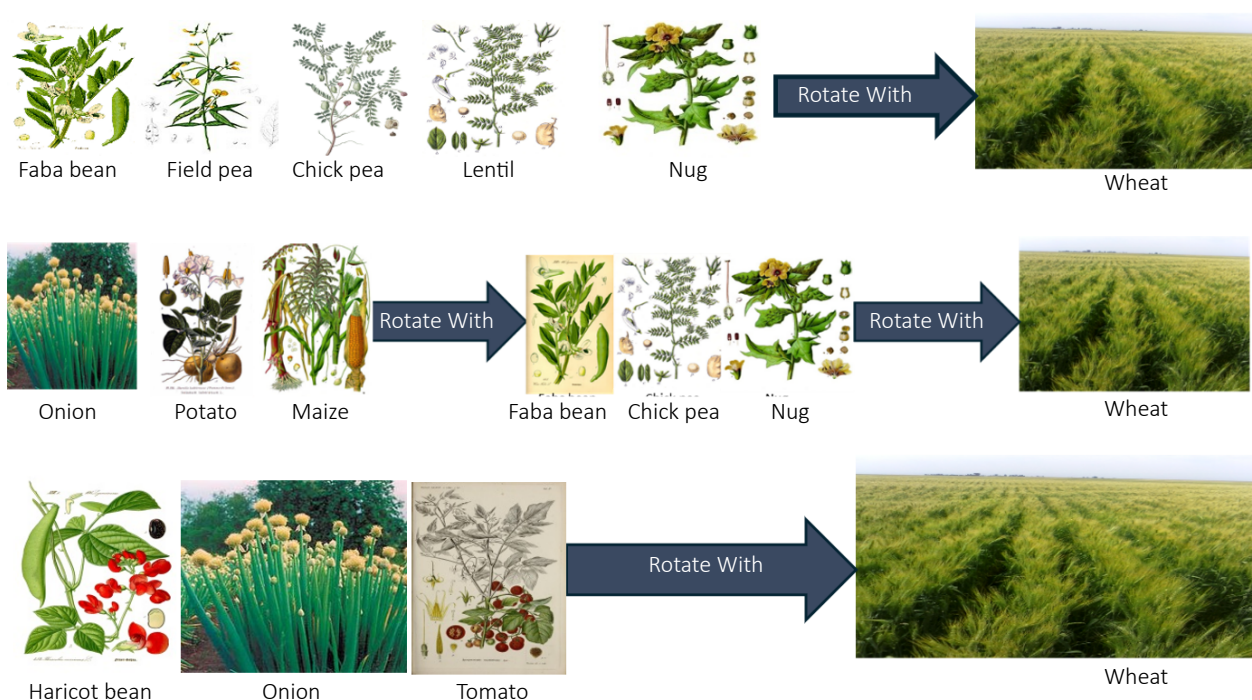
- It should be based on proper land utilization.
- It should contain soil improving crops to maintain and build up soil organic matter level.
- It should provide sufficient fodder for livestock reared on farm.
- It should be so arranged to make an economy in production and labour utilization.
- It should be so arranged to help in control of weeds, plant diseases and pests.
- Should provide maximum area under most profitable cash crop adopted in the area.

Advantage of crop rotation for wheat production

- Crop rotation maintains and improves soil fertility,
- Prevent buildup of pests, weeds & soil diseases.
- Control of soil erosion,
- Prevent or limit periods of peak requirements for irrigation water,
- Conserve moisture from one season to next,
- Increases crop yield.

Crops included in the crop rotation: Growing cereals, oilseeds and pulses in a long-term rotation has been shown to provide the best benefit to soils and crop yields.

The long-term wheat rotation with different crops based on the crop types grown are listed here:





Post assessment questions

- What are the main purposes of land preparation for growing wheat?
- What are the consequences of poor drainage management in wheat production?
- What is the appropriate row spacing for wheat cultivation using mechanical and oxen plows?
- When and at what rate should Urea and NPS fertilizers be applied for wheat



Key message

- Identify the optimal sowing window for your region to ensure proper germination and crop establishment, density.
- Use the recommended seed rate based on the seed size, germination percentage, and planting method.
- Maintain the appropriate row spacing and plant-to-plant distance to optimize resource utilization.
- Apply a balanced combination of organic and inorganic fertilizers to meet the crop's nutrient requirements.

SECTION 4. WHEAT FIELD PESTS AND THEIR MANAGEMENT

Wheat production requires diligent attention to pest management practices.

- Diseases like wheat rust and Fusarium head blight (FHB) can be particularly devastating, potentially causing up to 100% yield loss if not managed properly.
- In addition to diseases, wheat crops also face threats from various insect pests that should not be overlooked. Timely identification and management

of these insect pests are crucial to maintaining healthy wheat plants and achieving good yields.

- Furthermore, weeds are a major challenge in wheat production that necessitates careful attention. Weeds can compete with wheat plants for essential resources like nutrients, water, and sunlight, thereby significantly reducing wheat yields if left uncontrolled.

Therefore, it is of utmost importance to identify the major pests and diseases prevalent in the specific agro-ecological zone where wheat is being grown.

- This knowledge allows for the implementation of targeted and effective management strategies.
- Integrating multiple control measures, such as the use of resistant varieties, cultural practices, biological control, and judicious application of pesticides, is essential for comprehensive pest and disease management in wheat production.
- Continuous monitoring, timely interventions, and the adoption of Integrated Pest Management (IPM) principles are key to achieving sustainable and profitable wheat cultivation.



Learning outcomes

To identify the major wheat pests in general

- To identify the symptoms and sign for major wheat pests
- To determine the major wheat pests management options
- To be familiarized with the pesticide safe handling methods

Duration 4 hours



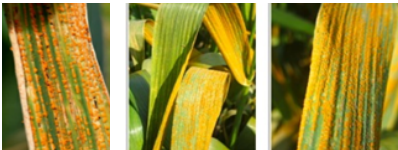
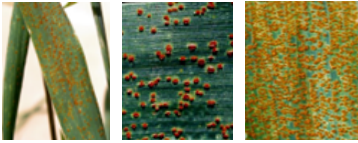
Learning question

- What are the most damaging diseases you heard on wheat crop?
- Why did you think managing grass weed on wheat is challenging?
- Discuss on effect of irrational use of pesticide on the human wellbeing?

4.1 MAJOR WHEAT DISEASES AND THEIR MANAGEMENT

- The major wheat fungal diseases are the three rusts (Stem rust, yellow rust and leaf rust), fusarium head blight, Fusarium crown rot, Septoria tritici blotch, Loose smut, Common bunt, Common root rot and Take-all.
- Accurate plant disease identification is the first step in designing effective and sustainable disease management programs.

4.1.1 DISEASES OF WHEAT LEAF AND STEM PART

MAJOR LEAF DISEASES	SYMPTOMS	MANAGEMENT OPTIONS
Stem Rust (<i>Puccinia graminis</i> f. sp. tritici) - High yield losses, if stem rust infected early in their growth and development - Losses of 100% can occur with susceptible cultivars. - Favorable conditions for stem rust are humid and warmer temperatures of 15 to 35 OC.	 - Causes elongated or large orange to red oval-shaped blister-like lesions pustules on stems, leaves, leaf sheaths, awns and glumes. - The reddish-brown spores of the fungus cause considerable tearing as they burst through the outer layers of the plant tissues.	- Timely planting, avoid late planting - Planting moderately resistant/tolerant cultivar - Destroy the green bridge and sowing healthy seeds of high quality - Rex® Duo, Nativio, Tilt 250 EC, Natura 250 EW etc. - Applications made between flag leaf emergence and flowering provide the most effective
Yellow or Stripe Rust (<i>Puccinia striiformis</i> f. sp. tritici) - The disease is most common on leaves, but head tissue also can develop symptoms when disease is severe. - The favorable condition for yellow rust is a disease of wheat grown in cooler environments (2 to 15 OC).	 - Blister-like lesions that are arranged in stripe - Usually form narrow stripes on the leaves.	- Planting moderately resistant/tolerant cultivar - Avoidance of excessive nitrogen use, and - Elimination of volunteer and grass plants can reduce stripe rust severities as they limit exposure time to inoculum
Leaf Rust (<i>Puccinia recondita</i> f.sp. tritici) - Favorable condition for leaf rust is humid and warmer temperatures of 10 to 30 OC. - Losses are usually low (>10%)	 - Small, orange-brown lesions are key features of leaf rust infections. - Lesions normally smaller, more round, and cause less tearing of the leaf tissue than those caused by stem rust	- Timely planting, avoid late planting - Planting moderately resistant/tolerant cultivar - Destroy the green bridge and sowing healthy seeds of high quality - Rex® Duo, Nativio, Tilt 250 EC, Natura 250 EW etc. - Applications made between flag leaf emergence and flowering provide the most effective
Septoria Tritici Blotch (<i>Mycosphaerella graminicola</i>)	 - This fungal disease causes tan, elongated lesions on wheat leaves. - The dark, reproductive structures produced by the fungus are key diagnostic features and can often be seen without magnification.	- Planting of resistant cultivars is the most economical and effective approach - Rotation to non-hosts and sanitation achieved by deep ploughing of crop debris - Timing fungicide sprays to periods when the pathogen is most likely to be active - A seed dressing of a fungicide, such as triticonazole

COMMON NAME-FORMULATION	TRADE NAME	RATE	TARGET DISEASE	CLASS
Epoxiconazole+Thiophanate-methyl	Rex Duo*	0.5 l/ha	Yr & Sr	Triazole
Pyraclostrobin+Epoxiconazole	Opera™ Max*	1l/ha	Yr	Strobilurin & triazole
Trifloxystrobin100gm + Tebuconazole 200gm/lit	Nativo SC300*	0.75 l/ha	Yr & Sr	Strobilurin & triazole
Propiconazole	Tilt 250 EC*	0.5-1 l/ha	Rusts	Triazole
Triadimefol	Noble 25 WP*	0.5kg/ha	Yr	
Azoxystrobin	Ecstar 250 SC*	0.5 l/ha	Yr	Strobilurin
Azoxystrobin 200gm/lit + Cyproconazole 80gm/lit	Amstar Xtra 280 SC*	0.5l/ha	Yr	Strobilurin& triazole
Propiconazole	Bumper *	0.5 l/ha	Yr	Triazole
Propiconazole	Panazole 25 EC*	0.5l/ha	Sr	Triazole
Triadimefon	BayletonWP*	0.5-1 kg/ha	Yr & Lr	
Triadimefon	Prevent 20 EC	0.65 l/ha	Yr	
Propiconazole	Topzole 250 EC*	0.6 l/ha	Yr	Triazole
Tebuconazole	Orius 250 EW	0.5 l/ha	Yr & Sr	Triazole
Tebuconazole	Natura 250 EW*	0.6 l/ha	Yr & Sr	Triazole
Epoxiconazole	Soprano	0.75 l\ha	Yr&Sr	Triazole
Propiconazole	Progress 250 EC	0.5 l/ha	Yr	Triazole
Picoxystrobin + Cyproconazole	Acanto® plus	0.5 l/ha	Yr	Strobilurin & triazole
Triadimenol	Sayfidan	0.5-1 l/ha	Yr	

Note: EC= Emulsified concentrate WP= Wettable powder, Yr= Yellow rust, Sr= Stem rust, Lr = Leaf rust

Table 4. Recommended fungicides to control rusts in Ethiopia

4.1.2 DISEASES OF WHEAT HEAD, SEED AND LOWER PART

MAJOR DISEASES OF HEAD AND LOWER PART	SYMPTOMS	MANAGEMENT OPTIONS
Stem Rust (<i>Puccinia graminis</i> f. sp. <i>tritici</i>) - Favorable Conditions is warm temperature, excessive moisture before and during flowering, and temperature between 10 and 28°C are required for infection. - FHB reduces yield and end-use quality, contaminates the grain with fungal mycotoxins such as deoxynivalenol (DON) and nivalenol (NIV).	 - Beaching of spikelets on the whole or parts of the head, tan or light brown lesions encompassing one or more spikelets and an orange fungal mass along the lower portion of the glume. - The kernels from infected spikelet's will be shrivelled, and are often discolored, ranging from pink to gray to light brown discoloration.	- Using resistant varieties is the most effective and economical to minimize losses - Using crop rotation, don't follow cereals particularly maize or sorghum crops to non-host crops, including pulses and forage legume crops. - Use high-quality healthy clean seed - Carbendazim 75% WP, Imidalm T 450 WS, Thiram 50% WP, and Apron Star WS are currently used as seed treatment to prevent infection - Application of Fuzaro, Pajaro plus 420 SC and Nativo SC 300 at the beginning anthesis or flowering stage (60ZGS)
Loose Smut (<i>Ustilago tritici</i>) This pathogen lives in the wheat seed till the germination and then it reaches to the shoots and infects the head part.	 - The normal head tissue of plants infected by loose smut is replaced by dark masses of fungal spores, giving the heads a black powdery appearance. - It is possible to see heads damaged by loose smut while much of the head is still inside boot.	- Most effective way to control over loose smut is the use of disease resistance variety - Systemic seed treatment (Thiram) and using disease-free seeds - To eradicate the disease always healthy, certified seeds should be used along with a fungicide as its very hard to identify the infected seed and a healthy one - Rouging and burring the infected plant is also crucial to control the spread

Take all (<i>Gaeumannomyces graminis</i> f.sp. <i>tritici</i>) Frequently, the disease is most severe in wet areas of a field and near field edges where the fungus survives in association with grassy weeds	 - Roots and lower nodes have a shiny black discolouration and premature death of the plant, resulting in patches of white heads in wheat - White heads are often observed on infected plants at or after heading	- Crop rotation with at least one year out of wheat or barley is very effective at reducing the pathogen population - Bury grassy debris to ensure breakdown of infected plant residues - Maintain good nitrogen levels. - Improve drainage
Common Root Rot (<i>Bipolaris sorokiniana</i>) A key diagnostic feature of the disease is dark-brown lesions on the thin stem extending from the base of the plant to the remnant of the seed	  - Causes premature death of wheat, resulting in patches of white heads scattered throughout a field - Infected plants are dark at the base and have poor root development.	- Crop rotation with a broadleaf crop and control of grassy weeds - Using resistant varieties is most effective - Use fungicide seed treatment where fields have a history of poor seedling emergence and root and crown rots.

4.2 MAJOR WHEAT INSECT PESTS AND THEIR MANAGEMENT

Due to widely cultivation in the main season (rainfed) and off-season (irrigation), Wheat is attacked by various insect pests like, Russian aphid, Termites, Armyworms, Brown wheat mites and Jassids commonly affect wheat at different growth stages.

MAJOR INSECT PEST	SYMPTOMS	MANAGEMENT OPTIONS
Russian Aphids (<i>Diuraphis noxia</i>) - Russian wheat aphid (RWA) is the major aphid pest of wheat. - In Ethiopia, the most severe infestations have occurred on rainfed in the highlands and everywhere on irrigated wheat.	   - These aphids feed on the upper leaf surfaces and roll up the leaves to produce a protected microhabitat where they can feed undisturbed. - Infested leaves exhibit purple or white longitudinal streaks.	- Chemical pesticides are recommended for this pest in wheat if the level of aphids per tiller crosses 10 during the vegetative phase and 5 during the reproductive phase - The spray of imidacloprid @ 20 g a.i. per ha initially on border rows and if infestation is severe then in entire field will give good protection against this pest - Application of Fuzaro, Pajaro plus 420 SC and Nativo SC 300 at the beginning anthesis or flowering stage (60ZGS)
Termites(<i>Odontotermisobesus</i>, <i>Microtermisobesi</i>)	  - Termites attack the crop at various growth stages, from seedlings to maturity. - The severely damaged plants look wilted and dried. On partially damaged roots, the plants show yellowing.	Effective and recommended insecticides such as endosulfan, chlorpyrifos and carbosulfan can be used both for seed treatment and broadcast of treated soil in standing crop

Armyworm (Mythimna separate) Armyworm is the only caterpillar found in large numbers in small grains. They are active at night, hiding under plant litter such as old corn stalks and at the base of wheat plants during daylight hours	 - Armyworm can cause serious defoliation, injury to the flag leaf, and cause head drop - The larvae are found in the cracks of soil and hide during the day but feed during the night or early morning. In wet and humid weather, they may feed during the daytime	- Diagnosis and monitoring (scouting approaches) - Phytosanitary measures (disking or deep ploughing) - Planting date adjustment (synchronized early planting) - Mechanical control (hand picking and squashing of caterpillars) - Insecticide application (pyrethroids, carbamates, and organophosphates category)
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4.3 MAJOR WHEAT WEED PESTS AND THEIR MANAGEMENT

- Weeds are plants, which grow out of their proper places and whose virtue has not yet been discovered.
- Weeds act as reservoirs for the multitude of pests and diseases, which use them as alternate hosts for food and shelter during the off-season period.
- It competes for nutrients, space, light, Co2 and exerts a lot of harmful effects on wheat
- This competition will ultimately reduce the growth, yield attributes, quality and yield
- Heavy infestation of broad, narrow or both-leaf nature weed species on wheat fields can adversely affect the productivity of the crop plant
- Most of the wheat-weed competition occurs within the first 20-30 days after sowing (DAS) at low to mid altitudes, and 30-40 DAS at high altitudes

S/N	SCIENTIFIC NAME	COMMON NAME	LOCAL NAMES (AMHARIC)
1	Avena abyssinica	Ethiopian oat	Sinar
2	Avena fatua	Wild oat	Sinar
3	Bromus pectinatus	Brome grass	Genchi
4	Cyperus rotundus	Nutsedge	Engicha
5	Lolium temulentum	Ryegrass	Enkirdad
6	Snoddenia polistachya		Muja



Table 5. Major narrow-leaved weed species in wheat fields

S/N	SCIENTIFIC NAME	COMMON NAME	LOCAL NAMES (AMHARIC)
1	Argemone ochroleuca	Munita	Nechi lebash
2	Bidens Pilosa	Devil's needles	Chegogit
3	Chenopodium album	Lamb squatters	Amedmado
4	Convolvulus arvensis	Bind weed	Timilmil
5	Datura stramonium	Jimsonweed	Atsefaris
6	Galinsoga parviflora	Galinsoga	Abadebo
7	Guizotia scabra	Sunflecks	Mechi
8	Persicaria nepalense	Knotweed	Yetija siga
9	Plantago lanceolata	Buckhorn plantain	Askir



Table 6. Major broad-leaved weed species in wheat fields

Methods of Weed Management

To reduce weed competition and increase wheat productivity, different weed management techniques have been used as follows.

- Weeds in wheat fields can be prevented by sowing weed-free crop seeds, using well-decomposed farmyard manure, harvesting the crop separately from the weeds, and thoroughly cleaning agricultural instruments before use on specific farmland
- Wheat rotational cultivation with legumes or oil crops over a long period reduces the population of highly competent weeds in the crop field. This includes sowing wheat after oil crops such as sunflower, rapeseed and Niger seed as well as pulse crops such as soybean, common bean and cowpea to reduce weeds and improve soil structure and fertility.
- Ploughing three times minimizes the quantity of weeds in wheat fields.
- Hand weeding within 30 to 40 DAS gives good weed control,
- If herbicide application is possible, supplementary hand weeding should be carried out 15 days after the herbicidal treatment to remove escaped weeds.
- To control various weed species in wheat fields, many post-emergence herbicides, both narrow and broad-spectrum, have been recommended (Table 4)
- No single management method is likely to offer long-lasting solution to the serious problem of weeds in wheat fields. Therefore, combining preventive measures, cultural practices and herbicide application found to be preferable for effective, economic and season-long weed management

TYPES OF WEEDS	HERBICIDE NAME	RATE (LT/HA)	WHEAT HERBICIDE APPLICATION GROWTH STAGE
Broad leaved weeds	Strane-M	1	2-5 leaves
	Banvel P	3.25	2-5 leaves
	Gran Star	20 grams	2-5 leaves
	Derbi	100 CC	2-5 leaves

Grass type and broad spectrum	Puma super	1	2 leave to 1st node
	Topic	1	3-6 leaves
	Pallas	0.45	3-6 leaves
	Round up	2	10-15 Days Before planting after weed emerged

Table 7. List of herbicides used to control wheat weeds



Figure: wheat farm weed controlled and weed infestation (uncontrolled farm)

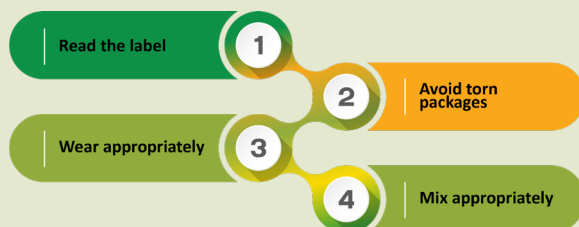
4.4 PESTICIDES SAFE HANDLING AND UTILIZATION

- Pesticides play an important role in agriculture and public health sector.
- However, pesticides contain hazardous substances and impurities that can pose series threats to human health and the environment if they are not properly regulated.
- Therefore, Sound management of pesticides and pests are critical for sustainable agriculture and achieving public health goals.
- Following proper safety protocols when handling pesticides is critical for the protection of both the farmers and the environment. Here are some key points on the safe handling of pesticides in wheat production:
 - Read and strictly follow the instructions on the pesticide label regarding mixing, dosage, and personal protective equipment (PPE) required.
 - Wear appropriate PPE like goggles, gloves, and a respirator during pesticide mixing, preparation, spraying and disposal.
 - Read and strictly follow the instructions on the pesticide label regarding mixing, dosage, and personal protective equipment (PPE) required.
 - Calibrate the spraying equipment to ensure even and targeted application of the pesticide.
 - Avoid spraying on windy days to prevent drift and unintended exposure.
 - Focus on spraying the target crop and avoid contaminating surrounding areas, water bodies, and non-target vegetation.

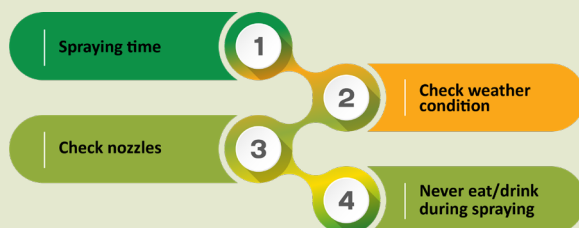
- Triple-rinse pesticide containers and use the rinsate to prepare the spray solution.
- Dispose of empty pesticide containers and any leftover spray solution responsibly, as per local regulations.
- Do not dump pesticides or their containers into water sources or landfills, as they can contaminate the environment

Safe use of chemicals

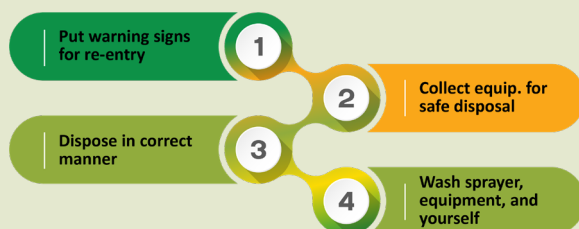
Safety Before Spraying



Safety During Spraying



Safety After Spraying



Post assessment questions

- What are the types of wheat rusts and differentiate their symptoms?
- List the major wheat insect pests.
- What time is critical to manage weed infestation in wheat crop after sowing?

Key message

- Closely monitor wheat fields to identify the major pests and diseases prevalent in the local agro-ecology
- Monitor pest populations and disease incidence regularly to make informed decisions on control measures.
- Always read and follow the instructions on the pesticide label regarding mixing, application, and safety precautions

SECTION 5. HARVESTING AND POST-HARVEST HANDLING

Learning outcomes

To identify the importance of appropriate harvest & post-harvest practices

- To know the time and methods of harvesting and threshing of wheat crop
- To be familiar with post-harvest handling practices

Duration: 1 ½ hours

Learning question

1. Why did you think that its crucial to know appropriate harvesting, threshing and storage time?
2. What's is the importance of Post harvest handling of Wheat?

5.1 HARVESTING AND THRESHING

Wheat harvesting and post-harvest handling are a crucial step in the cultivation process that requires careful planning and execution.

Here are some important points to consider when harvesting wheat:

Harvesting Time

- The time of harvesting and moisture content of the wheat crop along with the harvesting technique used are the crucial factors that decide the quality of wheat.
- Early harvest at higher moisture increases drying costs, vulnerability to mould growth, and disease infestation and leads to more broken seeds/ and less germination rate.
- Late harvesting increased shattering and grain loss during the harvesting and threshing operations
- The optimum moisture of the grain should be 13-17% at the time of harvest and 12-15% at the time of threshing.

Methods of Harvesting

- There are two methods of harvesting wheat, manual and combiner or mechanical
- The manually harvested wheat crop is tied into small bundles and stacked in bunches of 10- 15 bundles, which are left in the field for one to three days to dry.



Figure 1. wheat crop manual harvesting



Figure: Wheat mechanical and combine harvesting

Methods of Threshing

- The sheaves of wheat are carried to the threshing floor manually or on the backs of animals like camel donkeys and bullocks.
- The threshing and separation of the grain from the straw is done in a variety of ways.
- The wheat crop may be beaten with sticks or trampled by a bunch of animals.
- Animals may be used to draw a wheat bundle/ stone roller over the thick layer of the harvested wheat crop
- Combining harvesters are designed to perform efficient and thorough threshing and separation, minimizing grain losses and maximizing harvest productivity.
- They significantly streamline the harvesting process compared to manual or traditional methods, as they combine multiple operations into a single machine.

5.2 POSTHARVEST HANDLING

Transportation

- The loading and unloading of wheat predominantly involve manual handling, transferring the grain between wagons, trucks, railroad cars, barges, and farm or mill vehicles, depending on the quantity of the crop.

- The transportation of wheat grain is conducted using methods such as head carrying, bicycles, motorcycles, and vehicles, which vary depending on the amount of produce being transported.

Drying

- Drying is the systematic reduction of crop moisture down to safe levels for storage
- It is one of the key postharvest operations that ensures wheat grain quality
- During harvesting the moisture content of grain is between 18-24% for safe harvesting and reduce shattering.
- For wheat crops, it is recommended to have a moisture content of 12.5% after threshing and prior to storage.
- Harvesting, threshing and storing wheat with high moisture content attracts mold infestation that produces mycotoxin.

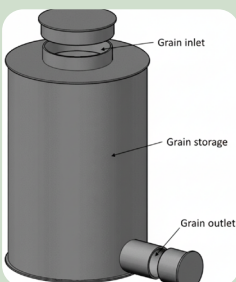
Storage

- Storage is the process of keeping grain until an appropriate time of use.
- The primary aim of storage is for quality maintenance, food & nutrition security, seed and better price.
- It is important to note that proper storage does not enhance the quality of grain, but it helps preserve its existing quality.
- Various storage technologies (traditional and modern) can be used by smallholder farmers to store wheat grain.

Traditional Technologies (Mud and wattle granaries, basket, pots)



Modern Hermetic storage (Metallic silos, Triple/Pics bag, PVC silo,)



General Hygiene Practices for good storage

Storage facilities and the surrounding environment should be kept in good hygienic conditions to ensure the quality and safety of the product:

- The store should be cleaned thoroughly before and after the storage of the produce.
- Bush surrounding the storage facility should be cleaned regularly to avoid inhabiting rodents and other insects.

- Ensure that the store is closed all the time and is open as and when required.
- Ventilators and other outlets should have screens that prevent rodents, birds and insects from entering the store.
- Flammable materials should not be kept near the food store.
- In case other types of food are kept in the store, each type of produce should be stacked separately to avoid the mixing of produce and cross-contamination.
- The air condition in the store should be kept less than 15°C to avoid pests production.



Post assessment questions

- What is the optimal moisture content of wheat grain for harvesting, threshing, and storing?
- Which method designed to perform harvesting and threshing simultaneously?



Key message

By paying close attention to the moisture content and optimizing the timing of harvesting and threshing, wheat growers can ensure the delivery of high-quality wheat grain to the market or for on-farm utilization.

SECTION 6. WHEAT GRAIN VALUE ADDITION PRACTICES



Learning outcomes

- To familiarize Wheat grain primary processing for marketing and Value-added products
- To provide learners with the necessary knowledge and skills to effectively oversee the cleaning and sorting processes in wheat grain production
- To teach with the necessary steps for grain cleaning and sorting
- To be familiarize with the types of grading based on the standard required

Duration: 1 ½ hours



Learning question

- *What are the main activities conducted during grain primary processing for market and storage?*
- *List the secondary value-added product of Wheat grain.*

6.1 WHEAT GRAIN PRIMARY PROCESSING

Cleaning, sorting, and grading wheat grain play a vital role in ensuring the quality, safety, marketability, and value optimization of the grain. These processes contribute to the production of safe and high-quality food products, maintain consumer satisfaction, and support efficient agricultural and food supply chains.

- Cleaning and sorting wheat grain contribute to its proper storage and extended shelf life.
- Cleaning, sorting, and grading ensure that the wheat grain meets specific quality standards.
- By removing impurities, damaged grains, and foreign materials, these processes help maintain the purity and integrity of the grain.
- Cleaning and sorting wheat grain help eliminate contaminants that may pose health risks.
- Grading wheat grain allows for categorizing the grains based on their quality characteristics.
- By removing impurities and separating the grains based on quality parameters, higher-

quality grains can be identified and sold at premium prices. This incentivizes farmers to produce high-quality wheat and allows buyers to procure grains suitable for their specific needs.

A well-sorted and cleaned wheat grain has several advantages:

- Improved milling and processing efficiency
- Enhanced visual appeal and uniformity of the grain
- Reduced risk of contamination and storage issues
- Higher market value and acceptance by buyers

Cleaning:

- Manual cleaning techniques involve physical separation of impurities from the wheat seeds.
- Winnowing is a common method where the seeds are tossed in the air using trays or sieves, allowing the lighter impurities to be blown away by the wind while the heavier wheat seeds fall back into the tray.
- Sieves or screens with different mesh sizes can also be used to separate larger impurities from the wheat.

Sorting:

- Sorting can be done in various ways, depending on the scale and resources available.
- Small-scale operations often rely on manual sorting, where workers visually inspect the seeds and remove any damaged or undesirable grains.
- Larger-scale operations may use mechanical sorting equipment, such as gravity tables or color sorters, to automate the process and improve efficiency.

Steps in practicing cleaning and Sorting:

Manual preparation of wheat seeds for sorting, cleaning, and grading requires skilled labor, attention to detail, and adherence to quality standards. While it may be more time-consuming compared to automated methods, manual processing allows for greater control and customization to meet specific market demands.



Grading

Wheat grain grading is a critical process in the grain value chain, from the producer to the consumer.

- Grading helps determine the quality of the wheat. Quality depends on what the grain is used for. These are directly linked to the value of the grain.
- Wheat is an important commodity in international commerce, and many attempts have been made to ensure reliability in grading.
- The grading system provides a range of maximum permissible levels for a variety of important characteristics and so determines the various grades. This ensures that grain complies with certain functionalities, as well as safety and hygiene, and is free from disease, harmful seeds, or other adverse factors within specific limits.

Method of grading

- The accuracy and consistency of the grading process play a crucial role in determining the market value and suitability of the wheat grain for various purposes.
- Grading wheat grain products for marketing involves assessing their quality characteristics and assigning them to specific grades based on predetermined standards.

Here are some common methods of grading wheat grain products for marketing:



Visual inspection

Visual inspection is a primary method of grading wheat grain products. Trained inspectors examine the grains for various quality attributes, including color, size, shape, uniformity, and freedom from defects. They compare the grains against established visual standards to determine their grade.



Size grading

The grains are passed through the sieves, and those that pass through each sieve are grouped into corresponding size categories.



Weight grading

Grains are weighed using scales or balances, and their weight per unit is compared to the standard weight requirements for each grade.



Moisture content determination

Moisture content is a critical factor in grading wheat grain products. Moisture meters or moisture testing equipment are used to measure the moisture content of the grains.



Other quality parameters

Depending on market requirements, additional quality parameters may be considered for grading wheat grain products. These can include foreign matter content, insect damage, kernel damage, and presence of mycotoxins.

6.2 SECONDARY VALUE-ADDED PRODUCTS OF WHEAT

Wheat grain can be processed into various value-added products that offer additional benefits and appeal to different consumer preferences. Here are some common value-added products derived from wheat grain:

TYPES OF PRODUCTS	DESCRIPTIONS	
Flour	Wheat grain is primarily milled into flour, which serves as a base ingredient for numerous food products.	
Bread and bakery	Wheat flour is a key ingredient in the production of bread and bakery items such as rolls, bagels, croissants, and pastries.	

Pasta	Wheat flour is commonly used to make pasta, including varieties like spaghetti, macaroni, fettuccine, and lasagna.	
Breakfast cereals	Wheat grain can be processed into various breakfast cereals, including flakes, puffed cereals, granola, and muesli.	
Wheat-based snacks	Wheat grain can be transformed into various snack items like wheat crackers, wheat-based chips, or roasted wheat snacks. These snacks cater to consumer demands for healthier snack options.	

SECTION-7 FINANCIAL FEASIBILITY

Overview of financial feasibility

Financial feasibility describes whether agri-business is financially viable. It involves determining initial investment (resource) requirement to start the business, estimating production cost, operation expenses, and sales revenue. These are used to determine the initial investment requirement, profitability of the business, break-even point (minimum level of production) to attain the profit zone, and pay-back period (number of years required to recover initial investment). These series procedures are used to make wise decisions to accept or reject the agribusiness investment alternative.



Post assessment questions

- What is the common method of wheat grain grading?
- List the advantage of proper sorting and grading?
- List the importance and drawbacks of manual sorting and cleaning?



Key message

- Investing time and effort in the appropriate sorting and cleaning of the wheat grain can pay significant dividends for farmers.
- It helps them deliver a high-grade, high-value wheat product that is more likely to be in demand and fetch a better price in the competitive marketplace.



Learning outcomes

To equip trainees on:

- How to determine initial investment requirement to start the business
- How to estimate periodical production costs, operating expenses, and sales revenue of the business
- How to determine profitability and cash flow of the business
- How to calculate break-even point (minimum level of production) to recover total cost and generate profit.

Duration: 1 ½ hours



Learning question

- Do you know how to determine financial feasibility of the given specific agri-business to make wise investment decision?

7.1 INITIAL INVESTMENT

- Initial investment is the minimum capital requirement to start the business.
- Example of initial investment requirement to start wheat grain production business includes tools and equipment, grain storage, land, tractor, working capital, etc

DESCRIPTION	TOTAL COST	REMARK
Tools and equipment		
Grain storage		
Land		
Tractor		
Working capital		
Etc		
Total		

Table 8: Template to estimate initial investment requirement for agri-business

7.1.1 LONG-TERM INVESTMENT

- Long-term investment in agri-business involves all asset requirements for the business which can serve for more than one year.
- Example tools and equipment, tractor, storage, land, etc

TYPES OF INVESTMENT	UNIT OF MEASUREMENT	QUANTITY	UNIT COST	TOTAL COST

Table 9: Template to calculate total cost for acquisition of long-term investment

7.1.2 WORKING CAPITAL

Working capital for the planned agri-business includes all payments requirement for day-to-day operating activities such as production costs and operating expenses.

Example

- Production costs include the cost of seed, fertilizer, chemical, labor cost etc.
- Operating expenses include administrative salary, sales commission, promotion, etc.



- Working capital excludes long term investments such as warehouses, tools and equipment, land, tractor, etc.

A. Production cost

- Production costs are a key component in agri-business.
- It includes all costs associated with production including value addition to making the product ready for sale.

TYPE OF COSTS	UNIT OF MEASUREMENT	QUANTITY	UNIT COST	TOTAL COST
Seed	KG			
Fertilizer	Qtl			
Insecticide	Litter			
Fungicide	Litter			
Herbicide	Litter			
Ploughing cost	Hour			
Land rent	Hectare			
Irrigation cost	Hectare			
Labor cost	Person			
Packing	KG			
Loading and unloading	Qtl			
Transporting	Qtl			

Storage if rental/ month	Number			
Etc....				
Total				

Table 10: Template for estimating production cost per hectare for wheat grain production

B. Operating expenses

- Operating expenses are all costs not directly associated with production.
- They are common costs incurred for administrative and selling activities.
 - Example administrative salary, promotion cost, sales commission, transport cost to sale, etc

TYPES OF COSTS	TOTAL COST
Administrative salary	
Utility (electric, water, tele.)	
Interest	
Promotion	
Sales commotion	
Tax	
Etc....	

Table 11: Template to estimate operating expenses for agri-business

7.2 ESTIMATED PRODUCTION AND SALE REVENUE

- Production volume is the main source of revenue for the agri-business to generate profit.
- Producers should determine the estimated average production volume from the planned production season.

Formula -1

Total production volume = Average production per hectare X Land size (ha)



- After determining the estimated volume of production, it is possible to determine the expected sales revenue for the planned production.

Formula -2

Total sales revenue = Total production volume X unit selling price



A	B	C	D	E	F
TYPE OF PRODUCT	LAND SIZE (HA)	ESTIMATED PRODUCTION QT/HA	TOTAL PRODUCTION QT (B x C)	ESTIMATED SELLING PRICE/QT	TOTAL SALES REVENUE (D x E)
Wheat Grain					
Wheat straw					

Table 12: Template for estimating volume of production and sale revenue

7.3 PROFIT AND LOSS STATEMENT

- The primary objective of any business is to generate profit.
- Profit and loss statement is the main tool to calculate profitability of the business.

- It is used to accept or reject the investment based on estimated profit.

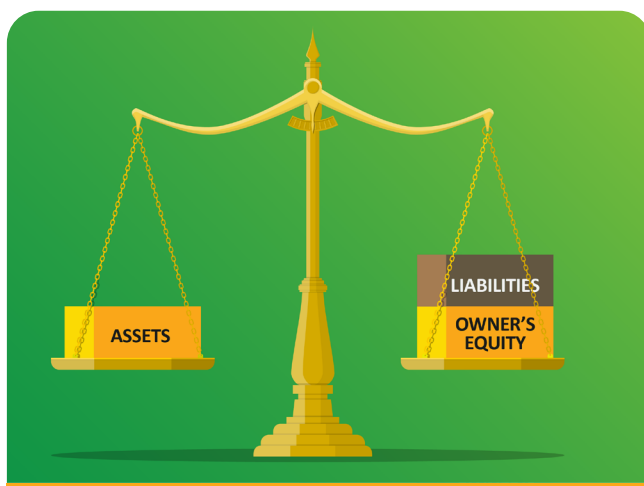
Formula -3

- Gross profit = Total sales revenue – Cost of goods sold
- Net profit = Gross profit – Total operating expenses

DESCRIPTION		
Sales Revenue		
• Sale of grain		
• Sale of straw		
Total Sales revenue		
Costs of goods sold		
• Grain production cost		
• Ending inventory		
Cost of goods sold		
Gross profit		
Operating Expenses		
Salary if any		
Utility (electric, water, tele.)		
Interest		
Promotion		
Depreciation		
Tax if any		
Total operating expense		
Net profit		

Table 13: Template for profit and loss statement preparation

7.4 BALANCE SHEET



Balance sheet used to know the total resource owned, amount of claim by creditors and amount of owners' equity

- Balance sheet contains assets, liability, and own capital
 - Assets are all resources available for use or for sale
 - Example cash, inventory, warehouse, land, equipment etc
 - Liabilities are all debts obtained from banks, microfinances, individuals or others
 - Own equity/capital involves own/member contribution, grant/donation, etc

Formula -4

Total Asset = Total liability + Total own capital

DESCRIPTION		
Asset		
Current asset		
Cash		
Inventory		
Total current asset		
Fixed asset		
Tools and equipment		
Warehouse		
Land		
Total fixed asset		
Total asset		
Liability and Capital		
Liability		
Bank loan		
Debt from relative		
Total liability		
Owners capital		
Own capital contribution		
Grant/donation		
Total owners' capital		
Total liability and capital		

Table 14: Template for balance sheet preparation

7.5 CASH FLOW STATEMENT



Cash flow is all cash inflow and outflow for any purpose in the business operation

Example:

- Cash inflows include sale of grain, debt obtained from banks, members capital contribution, etc
- Cash out flow includes purchase of input, payment for construction, repayment of debt, payment for salary, etc

Formula -5

Beginning cash balance + total cash inflow =
ending cash balance + total cash out flow

DESCRIPTION	AMOUNT OF OUTFLOW	AMOUNT OF INFLOW
Owners' investment		
Debt		
Grant		
Sale of grain		
Warehouse construction cost		
Purchase of equipment		
Purchase of input		
Land rent		
Irrigation cost		
Labor cost		
Cash Operating costs		
Ending cash balance		
Total		

Table 15: Template for cash flow statement preparation

7.6 BREAK EVEN ANALYSIS



- Break even analysis is used to determine the minimum level of production to cover total cost
- At break-even point no profit no loss
- To make profit, the level of production and sale should exceed/greater than breakeven point.
- Fixed costs are fixed in total amount regardless of increase/decrease in volume of production.
 - Example depreciation, warehouse rent, administrative salary, promotion cost, etc.
- Variable costs varied in total in response to increase/decrease in level of production
 - Example production costs, packaging cost, loading and unloading, etc

Formula -6

Break-even point = Fixed cost / (Unit selling price – unit Variable cost)

7.7 PAYBACK PERIOD

Payback period is used to determine the number of years/periods it takes to recover initial investment.

Formula -6

- When the annual profit of the business is uniform/equal
Payback period = Initial investment / annual profit
- When the annual profit fluctuate/vary from year to year
Pay back period = # of year before coverage + uncovered amount / profit of the next year



Post assessment questions

1. Which of the following is part of working capital
 - a. Purchase of fertilizer,
 - b. Purchase of tractor,
 - c. Transportation cost,
 - d. purchase of chemical
2. Which of the following should include in profit/loss statement
 - a. Purchase of tools and equipment,
 - b. Sales revenue,
 - c. Debt,
 - d. Owner investment

Risks and Mitigation measures

RISKS	MITIGATION MEASURES
Limited demand driven input/early generation seed supply	Create strong, sustainable, and diversified linkage with suppliers through contractual based early generation seed production, and last mile input delivery systems
Climate change	Use climate adoptive crop varieties, use irrigation scheme, use climate prediction information and trends of climate change, use diversification, understand effective crop Calander
Inflation/market fluctuation	Conduct effective demand assessment, understand competition in the business, apply cost-based pricing strategy, understand the market trend, use diversified market outlets
Limited access to finance	Create strong linkage with diversified source of finances such as banks, microfinance, use family/friends/partner, develop saving,
Insects and disease	Use quality and certified seed, apply crop rotation, understand the type of the insects/disease and use chemicals/manual mitigation method
Security	



Key message

- Determining initial investment uses to plan basic resources requirement to start the business
- Profit and loss statement is a key tool to determine profitability of the business
- Break-even point is a tool uses to know the minimum level of production requirement to attain profit zone
- Payback period uses to determine number of years requirement to recover initial investment

