

Chapter12

Innovations for Sustainable Agriculture

12.1.Fertilizer Tree

12.2 .Perennial Crops

12.3. Cover Crops

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12.1.Fertilizer Tree

- ❖ Trees play an important role in ensuring that our agricultural lands remain in good health.
- ❖ A very important condition for good plant growth and health and, indirectly, for good animal and human health is the timely provision of sufficient and balanced quantities of nutrients that can be taken up by the plant roots.
- ✓ Whatever the reasons farmers have for planting or protecting trees in a specific case, they nearly always fulfill several functions simultaneously.
- ✓ Trees may have been planted on a **hill slope to produce timber** or fruits, but they may also protect the soil from being eroded.
- ✓ Trees planted or retained for fodder are often **nitrogen-fixing** and may improve nitrogen availability in the soil.

- ✓ Similarly, trees that have been allowed to regenerate in a riparian zone because of environmental regulation, for firewood production or simply an appreciation of their **scenic value** may also filter nutrients from runoff water, thereby retaining them in the land-use system and protecting the river from eutrophication
- ❖ Fertile soils facilitate **root development, supply water, air and nutrients to plants**, and do not have pest and disease burdens that result in catastrophic impacts on the plants that are being grown
- ✓ Soil fertility is defined here as the ability of a soil to serve as a suitable substrate on which plants can grow and develop.
- ❖ Maintaining soil fertility is the basis of all forms of sustainable land use, that is, land use that remains productive in the long term.

- ❖ If fertility has fallen below a critical level through long-term agricultural use without replacement of nutrients or as a result of erosion, or if it is **naturally very low**, the replenishment of soil fertility may be a pre condition for **productive agriculture**.
- ❖ Trees can improve the nutrient balance of a site both by reducing **unproductive nutrient losses from erosion** and leaching and
 - ✓ by increasing nutrient inputs through nitrogen fixation;
 - ✓ they can improve soil structure,
 - ✓ water-holding capacity and crop rooting volume; and
 - ✓ they can increase the biological activity in the soil by providing biomass and a suitable microclimate.

❖ **Important reasons for having trees on farms**

➤ **Trees help control or reduce erosion in several ways, including:**

- ✓ By their roots binding soil particles together
- ✓ By acting as windbreaks, decreasing the wind's ability to dislodge and move soil particles
- ✓ Acting as a physical barrier, trapping moving soil particles
- ✓ Reducing the erosive potential of rainfall by providing a protective cover over the soil below

12.2 .Perennial Crops

- ❖ **Annual crops:** plants such as corn, wheat, rice, and soybean that are sown on a yearly basis—dominate our food system.
- ❖ **Perennials**, on the other hand, are planted once and live for years, producing many consecutive harvests.
 - ✓ This reduces the **need for soil tillage**, a practice that can lead to soil erosion and chemical run-off.
- ✓ Once established, perennial crops have extensive root systems with increased access to nutrients and water deep in the soil.
- ✓ **This makes them more drought-resistant**, which is especially important as weather patterns become more unpredictable as a result of **climate change**.
- ❖ **Perennials pull more carbon out of the atmosphere** and hold onto it longer in their biomass, helping to mitigate the aforementioned meteorological unpleasantness.

The advantages of perennial agriculture

- ❖ **Replacing annual crops with perennials holds many benefits for both developed and developing countries.**
 - ✓ **Perennial crops** are crops which are alive year-round and are harvested multiple times before dying
 - ✓ plants such as apples and alfalfa are perennials that are already commercially grown and harvested.
- ❖ **Conversion of annual fields into perennial fields offers many biodiversity-friendly benefits.**
 - ✓ **One of these benefits is reduced soil erosion.**
 - Annual farming leaves fields fallow in between growing seasons and offers less root mass throughout the growth cycle.
 - **This leaves fields vulnerable to wind and water erosion.**
 - *This erosion destroys topsoil which then pressures microbial and plant populations.*
- ✓ **Perennial plants develop much greater root mass and protect the soil year-round.**

- ❖ **Another benefit of conversion to perennial is reduced chemical runoff.**
- ✓ Farming chemicals such as **fertilizers and pesticides** are not completely absorbed by crops and the excess migrates into waters.
- ✓ **This water pollution is harmful to biodiversity in numerous ways**
 - ✓ **Perennials can reduce agricultural chemical runoff because their extensive root systems are more efficient at absorbing chemicals.**
- ✓ **For example, annual crops have been shown to lose up to 35 times more nitrogen than their perennial counterparts (Glover *et al.*, 2010).**

❖ **Perennial plants also conserve freshwater better than annual plants.**

- ✓ Annual crops lose up to five times more water than perennials (Glover *et al.*, 2010).
- ✓ This means that **annual fields require more irrigation** which threatens fresh water sources and consequently biodiversity in certain ecosystems.

❖ **Perennial agriculture uses less fossil fuel than annual agriculture.**

- ✓ Annual systems require **fields to be tilled and replanted** more often than perennial systems.
- ✓ This incurs a higher fuel usage due to **farm machinery**
- ✓ Annual grains live only one season, and therefore need to be planted every year.

The Benefits of Perennial Crops

❖ The main benefits of perennial crops are:

1. Make more complete use of annual rainfall

- ✓ Because perennial crops remain in the ground all year, their roots have access to all available rain water.
- ✓ The deeper roots of perennial crops are also able to tap deep-soil water reserves.
- ✓ Rainwater runoff is reduced because the soil is never left exposed; the thick **grass catches and directs rain water down into the ground.**
- ✓ Annual crops, compared to perennials, are relatively inefficient at capturing water and nutrients.

2. Reduce soil erosion

- ✓ Annual crops have relatively shallow roots depth but Perennial crops have extensive deep root systems
- ✓ This deep roots, perennial crops prevent top soil from washing away by preventing the soil from breaking up and eroding.
- ❖ **Annual crops remain in the ground for only part of the year, leaving the soil exposed between crop plantings.**
 - ✓ The exposed topsoil is liable to runoff during rains, contributing to the erosion of croplands.
 - ✓ **With perennial crops, the soil is never left exposed to the elements.**

3. Do not require annual cultivation

- ✓ The annual chore of ploughing under the stubble of previous crops and planting new seed is not necessary with perennial crops, which **saves energy and labor costs for grain producers**

4. Reduce the need for pesticides and herbicides

- ✓ When the soil is left exposed between crop rotations of annual grains, **weeds are able to gain a foothold in the empty land.**
- ✓ These weeds need to be controlled or eliminated with chemical treatments before planting successive annual crops.

- ❖ Healthy stands of perennial grains **block weeds from becoming established by denying sunlight and ground space to weed seeds.**
- ❖ Perennial crops save farmers the **expense of buying and applying pesticides and herbicides**, and reduce the impact of these chemicals on local watersheds.

12.3 Cover Crops

- ❖ **Cover crops** are those crop plants, which are able to **protect the soil surface from erosion** (wind, water or both) through their ground covering foliage and/ or root mats. *e.g.*, groundnut, sweet potato
 - A cover crop is grown to protect soil when there are no regular crops on it.
- ❖ Cover crops are grown as a **conservation measure** either during the **off-season or as ground protection under trees**.
- ✓ Cover crops are “close-growing crops that provide **soil protection, seeding protection, and soil improvement** between periods of normal crop production or between trees in orchards
 - ✓ Ground covers are **grown under tree crops to protect the soil from the impact of water drops falling from the canopy**.
- ✓ They are particularly important with tall crops such as rubber where the height of fall is sufficient to cause the drops to approach **their terminal velocity**

A cropland affected by rill and inter rill erosion



- ✓ In addition to protecting soil from erosion, **cover crops add organic matter to the soil and conserve plant nutrients** by taking up soluble nutrients which might otherwise be lost by leaching
- ✓ Use of cover crops not only reduces **runoff, soil erosion, and use of inorganic fertilizers** but also controls weeds, a major constraint in reduced and no-till systems
- ✓ Planting quickly growing crops, which establish an early canopy cover, are aggressive to suppress weeds



A dense vegetation cover;

- ✓ prevents splash erosion;
- ✓ reduces the velocity of surface runoff;
- ✓ facilitates accumulation of soil particles;
- ✓ increases surface roughness which reduces runoff and increases infiltration;

- ✓ Facilitates sustainability of production systems
- ✓ Providing protective soil cover
- ✓ Enhancing soil physical and chemical properties
- ✓ Improving soil fertility and plant nutrition
- ✓ Reducing soil water evaporation

Fig. Maize field without cover crop



❖ **Cover crops are innovative conservation practices, and are specifically grown for:**

- ☞ Protecting soil against erosion
- ☞ Improving soil properties
- ☞ Enhancing soil fertility
- ☞ Suppressing weeds (control weeds and pests)
- ☞ Fixing N
- ☞ Increasing soil organic matter content
- ☞ Mobilize and recycle nutrients
- ☞ Preventing leaching of nutrients
- ☞ Improving water quality
- ☞ Stabilize soil moisture and temperature
- ☞ Protect the soil during fallow periods
- ☞ Improve the soil structure and break compacted layers
- ☞ Increasing crop yields

Management of Cover Crops

- ❖ **Choice of a cover crop and its management are crucial to harnessing the maximum benefits.**
 - ✓ Cover crops comprise of **annual, biennials, and perennials grasses or legumes.**
- ❖ **Choice of species and management depend on the specific goals (e.g. erosion control, N build-up, weed suppression).**
- ❖ **Plowing under of cover crops reduces their benefit to soil erosion control** as opposed to leaving cover crop mulch on the soil surface that protects the soil **against erosion, increases soil organic matter content, enhances nutrient pools, and suppresses weeds.**

12.4 .Small Livestock Productions

Definition of Livestock

- ❖ Refers to any breed or population of animal kept by humans for a useful, commercial purpose.
- ✓ **Livestock** (singular or plural) is any domesticated mammal intentionally reared in an agricultural setting for the purposes of **profit or subsistence**, whether for:
 - ✓ food, fiber, dairy,
 - ✓ draft, breeding,
 - ✓ sport purposes, or
 - ✓ other product or labor
- ❖ Pastoralists in Ethiopia keep several species of livestock including **cattle, goats, sheep, camels, and donkey**

Purpose of animal rearing

❖ Livestock are defined, in part, by their end purpose as the production of **food or fiber, or labor**.

❖ **The economic value of livestock includes:**

1. Meat

✓ Livestock can be raised for the production of a useful form of dietary protein and energy

2. Dairy products

✓ Livestock can be used as a source of milk, which can in turn easily be processed into other dairy products, such as yogurt, cheese, butter, ice cream, kefir, and kumis.

✓ Using livestock for this purpose can often yield several times the food energy of slaughtering the animal outright.

3. Fiber

- ✓ Livestock produce a range of fiber/textiles.
- ✓ For example, **sheep and goats produce wool and mohair**; cows deer and sheep can make **leather**; and bones, hooves and horns of livestock can be used.

4.Fertilizer

- ✓ Manure can be spread on **fields to increase crop yields**.
- ✓ This is an important reason why historically, plant and animal domestication have been intimately linked.
- ✓ Manure is also used to make plaster for walls and floors and can be used as **a fuel for fires**.
- ✓ The blood and bone of animals are also used as fertilizer.

5. Labor

- ❖ Animals such as horses, donkey, and yaks can be used for mechanical energy.
- ✓ Prior to steam power livestock were the only available source of non-human labor.
- ❖ They are still used for this purpose in many places of the world, including plowing fields, transporting goods, and military functions.

6. Land management

- ✓ The grazing of livestock is sometimes used as a way to control weeds and undergrowth.
- ✓ For example, in areas prone to wild fires, **goats and sheep are** set to graze on dry scrub which removes combustible material and reduces the risk of fires.

❖ **A herd is usually made up of several species of livestock.**

Advantages of keeping diverse species

- ❖ **Sheep and Goats** can easily be sold one by one thus providing money to meet the family's daily needs without having to sell cattle
- ❖ In the event of animal disease not all animals will die and it serves as some sort of insurances
- ❖ **Goats and camels** are able to feed themselves directly from **trees and thus don't lose as much weight in the dry season** and remain type of livestock that they are relied upon etc.

❖ **It demands more labour as :**

- ✓ the animals do not go to pasture together and
- ✓ do not eat the same type of pastures
- ✓ May require different water sources.

❖ Within these different species, there are different breeds
some of this breeds are:

- ✓ **better walkers,**
- ✓ some are **better producers of milk,**
- ✓ some are **more drought and disease resistant**

❖ **Livestock products contribute to subsistence in two ways:**

- ☞ Directly, via milk and meat for `home consumption
- ☞ Indirectly, via sales to generate **cash or exchanges for cereals and other crops**

- ❖ The contribution of crop production to household income in pastoral systems is practically zero, while other sources of income (mainly remittances, off-farm work, etc.) contribute between 0 and 43 percent.
- ❖ Milk is reported to contribute up to 80 percent of the diet in the rainy season among the pastoralists of east Africa.
- ❖ Other outputs, such as **skins and hides**, are also of economic importance in pastoral systems.
- ❖ **Goats and sheep** are valued as a source of meat, as well as a resource that can be sold for cash.



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❖ **Advantages of indigenous breeds of livestock**

- ✓ Accustomed to local disease situation
- ✓ Lower disease control requirements
- ✓ Good walkers in search of water and pasture
- ✓ Can live on low quality feed as occurs in the dry season
- ✓ Adapted to the high temperatures in pastoral areas
- ✓ Can lose weight during the dry season and easily recover thereafter
- ✓ Highly productive relative to the harsh environment
- ✓ High twinning rates among small stock

12.4.1.Livestock management in Pastoral Areas

1.Mobility

- ❖ Pastoral communities make well-planned and targeted movements between wet and dry season grazing areas as one mechanism of their animal management.
- ❖ Mobility is a strategy suitable to the fragile land on which pastoralists live.
- ❖ Allows communities to best use limited **pasture, water** and **other** resources.
- ❖ Mobility allows pastoralists to balance and conserve rangelands through careful management.

❖ **In Ethiopia, pastoralists' prime reason for moving is to search for better:**

- ✓ **grazing,**
- ✓ **water and**
- ✓ **saltlicks** (the different minerals which are an essential ingredient for animal health) and
- ✓ **to avoid disease.**





❖ **The stocks of sheep and goats at 2002-2005 in Borena on average.**

- 15% and 10% increase in sheep and goats flock.
- shoats' flocks were less dynamic than that of cattle herd.
- births were the most important component of sheep and goats inflows.
- ✓ sheep birth accounted for 84% the inflows
- ✓ Goats birth accounted for 86% the inflows

❖ Purchases accounted only for about 8% of the inflows for both sheep and goats.

❖ Thus, compared to cattle, for **sheep and goats births** were also very important than **purchases** from the market in building and maintaining the size of sheep and goats flocks.

➡ ***There are five components of sheep and goats outflows:***

✓ ***Deaths, Sales***

✓ ***Slaughters , Gifts, Thefts***

✓ **Deaths, sales, and slaughters** the major components of sheep and goats outflows

✓ **Sheep death and sales** accounted for about 44% and 22% of sheep outflows respectively.

✓ **Goats death and sales** accounted for about 52% and 34% of goats outflows respectively.

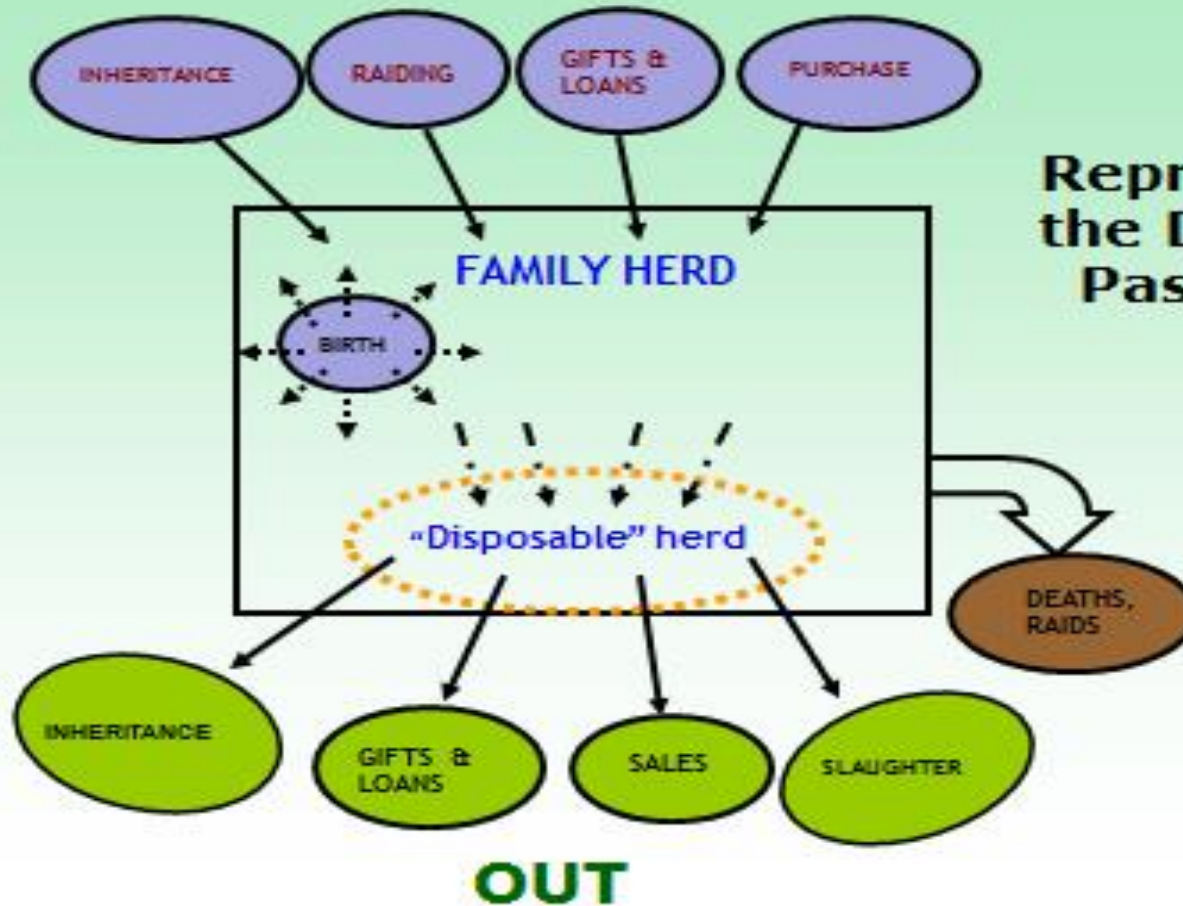
❖ **The slaughter accounted for:**

✓ 25% of sheep out flows

✓ 9% of goats out flows

❖ The high death rates of sheep and goats indicate the potential of increasing sheep and goats sales just by reducing sheep and goats' mortality.

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**Pictorial
Representation of
the Dynamics of a
Pastoral Family
Herd**

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Figure 4: The means of inflow and outflow of livestock of pastoralist family herd

12.5 .Crop-livestock (mixed) production systems

✓ Mixed systems are found in the semi-arid, sub-humid, humid and highland zones.

✓ However the term mixed farming systems has a dual meaning:

1.The farming system is based on livestock but practiced in proximity to, or perhaps in functional association with, other farming systems based on cropping and

2. Livestock subsystems of integrated crop-livestock farming.

✓ In the mixed production systems, cattle play an important role by **supplying draught**, while equines are the highland beasts of burden.

✓ Small ruminants and poultry are the main source of **cash and family consumption**.

✓ In the higher areas (above 3 000 m) barley and sheep predominate.

- ❖ A major characteristic of mixed farming systems is the varying degree of interaction between **crops and livestock**.
- ❖ Closely related to degree of economic dependence on livestock, mixed systems have also been defined as those which derive between 10 and 50 percent of gross revenue from **livestock, or in other words 50 percent** or more from cropping.
- ❖ The basic principle of these systems is that **rain fed agriculture is the main source of income**, although livestock provide an important additional source.

❖ The integrated crop-livestock farming systems are characterized based on three criteria.

❖ These are:

- 1. Agro-climatic conditions, in particular rainfall and cropping pattern,
- 2. Pressure of human population, as expressed by the cultivation intensity and
- 3. Overall importance of livestock, as expressed by livestock densities and species.

- ❖ **The mixed systems of the highlands have special features that justify their separate consideration.**
- ✓ Good soils and suitable climatic conditions, **allowing higher crop productivity and consequently higher population densities;**
- ✓ High cropping intensities and more or less permanent cropping patterns as a result of generally high population pressure;
- ✓ Crops are grown that are unsuitable for the lowlands, such as wheat, barley, teff, maize, coffee and tea;
- ❖ **Crops and livestock** are normally produced within the same management unit, hence approaching the concept of mixed farming and
- ✓ Ecological conditions suitable for the intensification of both crop and livestock production through the introduction of varieties and breeds from temperate zones.

12.6 Policy- Accessing Product to Market

- ✓ In general most of the **producers** sell the **grains** at their **door steps** in villages, to avoid transport.
- ✓ At village level **defective measures and weights** are used by **traders** and also the **prices paid to farmers** are much lower than **regulated market rates**.
- ❖ **Now-a-days farmers are encouraged to sell their produce in nearby regulated markets, though some labor is involved in transport.**
- ✓ In regulated markets some amenities are **provided for sellers and the growers** can **secure maximum value for their produce**.
- ✓ Since the rural banking system is improved the farmers to a large extent they are out of clutches of greedy private money lenders who exert pressure to dispose produce for lower price.

❖ *Marketing facilities*

- ✓ Mostly marketing facilities are available near the town, cities and agro based processing industries.
 - ✓ Farmers prefer a crop, the producer of which will fetch high price in the market.
 - ✓ In earlier days sunflower and soybean were grown in limited areas due to lack of processing industry.
 - ✓ **Now, due to industrial development they are grown in large scale.**
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- ## ❖ Based on this criteria farmers select the **high yielding varieties of maize, sorghum, sunflower and hybrid maize, hybrid cotton** that produce more yield than local varieties.
- ✓ Generally farmers are interested to grow the **hybrids to get maximum monetary benefits *i.e.*, more income per rupee invested**

- ❖ At present in some places the **cold storage facilities** are also available.
- ✓ Farmers can utilize these **cold storage facilities** for stocking their **produce on payment of rent** and the produce can be disposed when there is **remunerative price in the market**.
- ✓ Though several measures are taken by government **the marketing of agricultural produce** is facing problems and growers are **not getting the reasonable price for their produce**
- ✓ **If production exceeds demand, price declines** until the market is cleared.
 - ✓ Prices rise when production fell short.
 - ✓ Responses to **lower or higher prices** occur in the next production cycle.

❖ **Therefore,**

- ✓ The acreage for a particular crop based on **demand and the supporting prices for each commodity** need to be monitored by the **rulers based on demand and supply studies**

❖ **The government has to:**

- ✓ **bring buyers and sellers together,**
- ✓ **develop price information systems,**
- ✓ **establish consistent grades and**
- ✓ **product quality standards for better marketing of agricultural produce at all times.**