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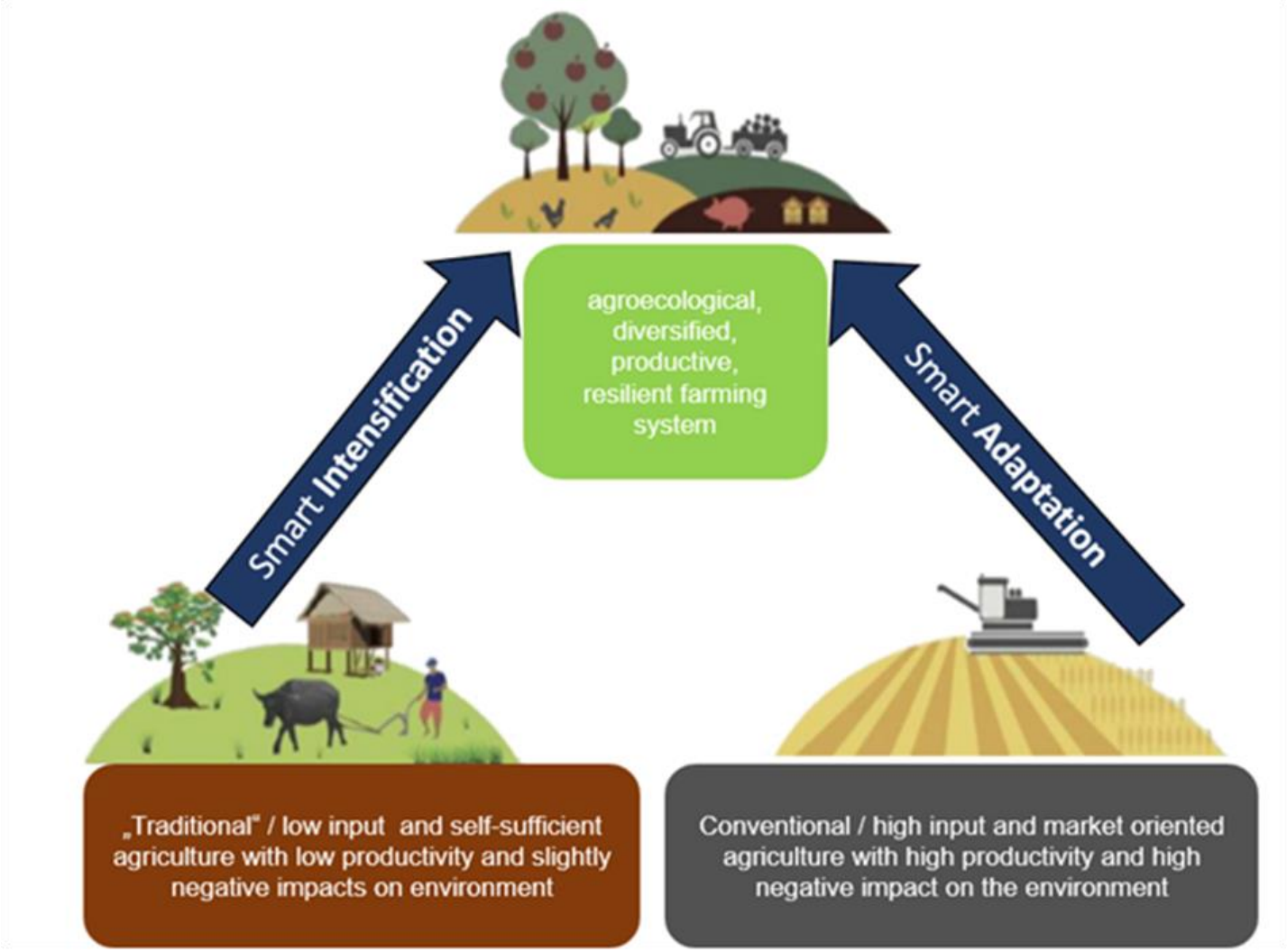
Agroecology

An Extension Training Manual



February 2022

Combining the Advantages of "Traditional and low input agriculture" with those of "Industrial Agriculture"

Published by

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices:
Bonn and Eschborn, Germany

ProSilience - Commissioned by the German Federal Government, co-funded by the European Union
Integrated Soil Fertility Management Project (ISFM+), Federal Unit GIZ Ethiopia

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Photo credits
T. Wehinger 2020, adapted from IPES Food 2016 & Backes, 2020

GIZ is responsible for the content of this publication

On behalf of
German Federal Ministry for Economic Cooperation and Development (BMZ)
and co-funded by the European Union

Addis Ababa, Ethiopia

February 2022

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Implemented by

What is agroecology?

Agroecology can be understood as a science, a set of practices and a social movement, which has evolved to expand in scope from a focus on fields and farms to encompass whole agriculture and food systems. It now represents a multi-disciplinary field that includes ecological, socio-cultural, technological, economic and political dimensions of agri-food systems from production to consumption.

Agroecology is increasingly promoted as contributing to transforming food systems by applying ecological principles to agriculture and ensuring a regenerative use of natural resources and ecosystem services. At the same time agroecology should address the need for socially equitable food systems within which people can exercise choice over what they eat and how and where it is produced.

Integrated soil fertility management is an integral component of agroecology.

This manual

This “Agroecology” Extension Training Manual has been developed as an extension to the technical manual on Soil Fertility Management. It outlines the concepts and principles that can guide the transition towards agroecology and provides practical examples of technologies and practices that support agroecological approaches. It is intended to be used as a learning aid for experts and development agents on levels and principles of agroecology to be used in association with the technical manual on soil fertility management.

Acknowledgements

We would like to thank the European Union (Directorate-General for International Partnerships, EU DG INTPA) for financial support as well as the Ethiopian Ministry of Agriculture (Soil Fertility Improvement Directorate, MoA SFID) for their suggestions. Moreover, we are grateful to Dr. Hailu Araya and Dr. Abbadi Girmay for their valuable technical inputs. Finally, we thank Mr. Jim Ellis-Jones for his dedicated editorial work as well as all those who directly and indirectly contributed to the production of this extension training manual.

CONTENT

Executive summary

There is consensus that global food systems are not delivering good nutrition for all and is causing environmental degradation and loss of biodiversity, requiring changes to meet the challenges of persistent malnutrition and rural poverty, aggravated by the growing consequences of climate change. Agroecological approaches have gained prominence in scientific, agricultural and political discourse in recent years, suggesting pathways to transform agricultural and food systems that address these issues.

Agroecological approaches contribute to halting agricultural land degradation, improving soil fertility, yields and income. It enables farmers´ to adapt to climate change and increases their resilience. Its goal is to increase food security by minimising the use of external inputs and maximising the use of local resources.

Agroecology can be understood as a scientific discipline, a set of farming practices and a social movement. As such, it extends beyond farming practices. There is no set definition but rather 13 principles that have emerged to provide guidance to understand its meaning. These principles are the basic building blocks for its implementation providing guidelines for the transition to a sustainable agricultural and food sector. Each principle can be broadly categorised under one of three main aims:

- **Improving resource efficiency:** recycling, input reduction, soil health and animal health.
- **Strengthening resilience**: biodiversity, synergies and economic diversification.
- **Securing social equity and responsibility:** co-creation and sharing of knowledge, social values and diets, fairness, connectivity, land and natural resource governance and importantly participation.

Agroecological transformation takes place across five interlinked levels. These can be viewed as a continuous transition path from a baseline with little or no agro-ecological integration often associated with both modern conventional agriculture and degraded traditional farming systems. Levels 1-3 focus on the agroecosystem, involving changes that farmers can make themselves on their own farms. Levels 4 and 5 focus on the entire food system and the communities in which they are embedded.

This manual focuses primarily on Levels 1-3, being those that can be implemented by farmers. In practice it is often difficult to determine which practice fits which level as there are many overlaps depending on local circumstances. Certainly, all the practices associated with integrated soil fertility management contribute to agroecological approaches. Examples are provided for each of the 13 principles, more especially those under levels 1-3.

Alternate pathways are described, firstly from traditional low input agriculture with low productivity and secondly from a conventional high input high output system both with negative impacts on the environment. For both the starting point is level zero with little or no agroecological integration but moving up through levels with initial emphasis placed on improving the efficiency of use of industrial inputs, then introducing environmentally friendly alternative inputs and practices until level three is reached when the agroecosystem is wholly redesigned.

Examples include the increased use of farm biomass products, the use of composts and manure, nitrogen-fixing legumes, cover crops, green manures and crop rotations all designed for improving soil health and crop productivity.

1 Introduction and definition of agroecology

The transformation of agriculture and food systems will be a central task of the coming years. Ensuring food security for a growing population, maintaining healthy ecosystems, supporting livelihoods and the wider economy, reducing climate risks and lowering greenhouse gas emissions are core objectives of future-proof agriculture and food systems. Suitable solutions will require the integration of as many system components as possible – from food cultivation, marketing and processing to consumption, including the relevant political and social environment. Given the complexity of the issue, agroecology has now established itself in scientific and political debate to address this task. Provided it is implemented effectively, agroecology has the potential for the socio-ecological transformation of agri-food systems and at the same time strengthening human, animal and environmental health (HLPE, 2019).

What is agroecology? Agroecology can be understood as a scientific discipline, a set of farming practices and a social movement. As such, it extends far beyond farming practices. There is no set definition but rather 13 principles that have emerged to provide guidance to understand its meaning (FAO, 2018; HLPE, 2019; Wezel, 2020). These principles are the basic building blocks for its implementation providing guidelines for the transition to a sustainable agricultural and food sector.

Agroecology as a scientific discipline: As a scientific discipline, agroecology studies processes and cause-and-effect relationships on agricultural land. In addition, it looks at the interdependencies between agriculture and semi-natural ecosystems, such as nearby forests and water bodies. Recently, challenges arising from analysis of socio-ecological systems and from political ecology have also been included in the scientific discussion.

Agroecology as a farming practice: Agroecological practices are local-specific methods that use, preserve and improve biological and ecological processes in agricultural production. They can reduce the use of external inputs, such as inorganic fertilisers and synthetic agrochemicals, and create diverse, resilient and more productive agroecosystems. At their core is the promotion of positive interaction and synergy between plants, animals, soil, water and the agri-food system. Agroecological farming places a strong focus on diversification, through practices such as mixed and inter-cropping, agroforestry, use of locally adapted seeds, biological pest control and management, composts, green manures and cover crops, amongst others. Integrated soil fertility management practices play a key role in agroecological approaches. They target in particular soil structure, the regulation of water balance as well as soil and plant health. Although organic farming has much in common with agroecology, agroecology does not rule out the use of inorganic inputs where these are essential for correcting nutrient imbalances or pest problems.

Agroecology as a social movement: Agroecology goes beyond farming practices, incorporating social and political dimensions with which it aims to strengthen agri-food systems. As a social movement agroecology strives to empower small-scale farmers, who often find themselves deprived of their rights and lack services such as agricultural education and advice. It also aims to transform local agri-food systems on the basis of the right to food. By generating local added value, reducing the distance to markets and through fair and safe food production, agroecology aims to strengthen the economic viability of rural areas. It supports various forms of small-scale agricultural production as well as food sovereignty, local knowledge, social justice, local identity and culture. This extends to controlling access to land, seed, water and fair-trade relations.

2 Ethiopian agriculture

2.1 A brief history

The world's food systems are heaping costs onto future generations and onto the planet. Although food production has tripled over the last 40 years, a billion people are now facing hunger and malnutrition with the way that food is produced and consumed being often unsustainable. This is

- ...putting pressure on soils, water, biodiversity, climate, and weather systems,
- ...increasing the risk of zoonosis and the threat of antimicrobial resistance,
- ...effecting the world's poorest who depend most directly on the free services that nature provides.

So, working together to help prevent ecological collapse and famine is now more important than ever (Parmentier, 2018).

Agriculture has a long history in the Horn of Africa, 12,000 years in the Nile Valley (Janick, 2014) and 7,000 years in Ethiopia (Berhan, 2006), providing support for millions of people over millennia across highly varied agroecological areas. This has included livestock rearing in arid and semi-arid areas, mixed farming in highlands and nature-based systems in wet humid areas.

Today a major component of Ethiopia's economy is reliant on agriculture comprising crop, livestock, fishery and forestry sub-sectors. These contribute 47% of the country's Gross Domestic Product (GDP), 90% of export earnings, 80% of employment, 70% of the raw materials for agro-based domestic industries and is the major source of the country's food. The crop sub-sector dominates contributing more than 60% of agricultural GDP with the livestock sub-sector contributing another 20%. The agricultural sector is mainly rain-fed, characterized by small scale mixed farming systems. Rain-fed agriculture predominates with over 90% of the total crop area producing over 90% of total output. Land holdings are small, generally ranging from between 0.5 and 1.5 ha per household.

2.2 The main challenges

The global food system is presently at a crossroads (HLPE, 2019) due to population growth, land degradation and climate change with agriculture unable to produce sufficient due to declines in soil health and fertility. At the same time, agricultural practices and farming systems are changing through the modernisation of agriculture with scientists and policy makers focusing on increasing food production. Unfortunately, rapid agricultural change can be costly and often unsustainable, especially when wider environmental and social issues receive little attention. For instance, the Green Revolution often failed to ensure safe and abundant food production in smallholder farming systems with cereal yields declining due to lack of ecological regulation mechanisms with monocultures being heavily dependent on inorganic fertilisers and pesticides (Altieri and Nicholls, 2012).

In Ethiopia, the use of these inputs remains low even by the already low standards of Sub-Saharan Africa with yields per unit of land remaining low (FAO 2017). Despite steady growth, the agricultural sector has failed to keep up with the increasing demands of a growing population. Productivity declines have been caused by many factors including increasingly erratic rainfall, frequent droughts, declines in soil fertility and associated land degradation (Hurni et al, 2010).

Land degradation and climate change now threaten progress made in poverty reduction and improving food security. Natural resources have been exploited for a long period without appropriate conservation practices. Inappropriate use has led to environmental degradation,

decrease in productivity and deep-rooted poverty. Land degradation is manifested in many ways through deforestation and species loss, habitat destruction, loss of biodiversity, soil erosion and declining soil fertility with consequential loss in agricultural productivity and ecosystems deterioration (FAO, 2019a). The agricultural challenges impacting on the countries food system include both bio-physical and socio-economic ones.

- **Bio-physical challenges:** Land degradation; agro-biodiversity decline; climate change; and infestation of new types of insects, pests, diseases and weeds. Land degradation includes all the process that reduce the capacity of natural resources to perform essential ecosystem functions and services through physical erosion, overgrazing, chemical degradation (comprising acidification, salinization, fertility depletion and decrease in cation retention capacity), physical degradation (comprising crusting, compaction, etc) and biological degradation (reduction in total and biomass carbon and decline in land biodiversity (WMO, 2006; Hurni et al, 2010; Hussein, 2017). Pollution and contamination of water, air and soil are growing problems in rapidly growing residential and industrial areas. This leads to loss of agricultural land and health risks from urban waste.

- **Socio-economic challenges.** These include increasing population, poor access to market and free-range grazing practices. Demographic change includes a high rate of growth with almost half of the country's population being under fifteen years of age. This has led to serious overcrowding in the cities, leading to a rapid deterioration in living conditions, including high unemployment, inadequate and squalid housing, poor urban services, and mounting crime (Inter Africa Group, 1995). At the same time, lack of market access and low prices have discouraged production.

The Ethiopian Government has developed policies and strategies to address these challenges including: A Rural Development Strategy, Climate Resilient Green Economy (CRGE) Strategy, Reduction Emission from Deforestation and Forest Degradation (REDD+), National Adaptation Plan of Action (NAPA), Nationally Appropriate Mitigation Options (NAMO) and Climate Resilience Strategy aimed at poverty alleviation, natural resource conservation-based agricultural development, gender equality, inclusiveness and empowerment.

Agroecology can support these policies and strategies.

3. Agroecology in Ethiopia

3.1 Agroecology's evolution

The term agroecology first appeared in the 1920s as an understanding of the application of methods of ecology to processes of agronomic research. During the 1960s, 1970s, and 1980s agroecology evolved to describe an ecosystem modified by human activity for exploitation purposes. During the 1990s and 2000s, agroecology further evolved to understand and define the entire system of production, distribution and consumption of food resources in all its components (agricultural, economic, environmental and social). As such agroecology has now evolved as a scientific discipline from one based on agriculture and the environment to include social and cultural disciplines as well as economic and policy ones.

Agroecology has also evolved in reaction to modern intensive industrial agriculture. Modern agriculture, developed during the 20th century, massively increased food production but often at a high ecological cost. Today, the scientific community agree that many ecological problems are due to intensive agriculture. For example, the massive use of inorganic fertilisers and pesticides and degradation of soil quality, loss of biodiversity, homogenization of crops and the effects of global warming are all partly due to modern intensive agriculture. At the same time traditional farming systems have become degraded as population has increased and use of natural resources has become unsustainable.

3.2 Ethiopia's main agroecological zones

Ethiopia's agroecological zones are based on physical and environmental factors, comprising major areas of broadly homogeneous land in terms of temperature and rainfall, topography, landscape, vegetation, soils and land use (Panabokke, 1979 and Hurni 1998). Table 1 shows the traditional agroecological classification based largely on altitude and comprising six major types.

Table 1: Ethiopia's traditional agroecological areas

Name	Description	Altitude m.a.s.l.[1]	Main land uses
Bereha	Hot lowlands	<500	In the arid east, crop production is very limited In the humid west root crops and maize are grown.
Kolla	Lowlands	500 - 1,500	Sorghum, finger millet, sesame, cowpeas, groundnuts
Woina Dega	Midlands	1,500 - 2,300	Wheat, teff, barley, maize, sorghum, chickpeas, haricot beans
Dega	Highlands	2,300 - 3,200	Barley, wheat, highland oilseeds, highland pulses
Wurch	Highlands	3,200 - 3,700	Barley is common
Kur	Highlands	>3,700	Primarily for grazing

[1] metre above sea level

This classification has been modified to identify five broad-based agroecological zones based on moisture availability (Figure 1) with a further 33 sub-zones (not shown) used for detailed research (EIAR, 2011).

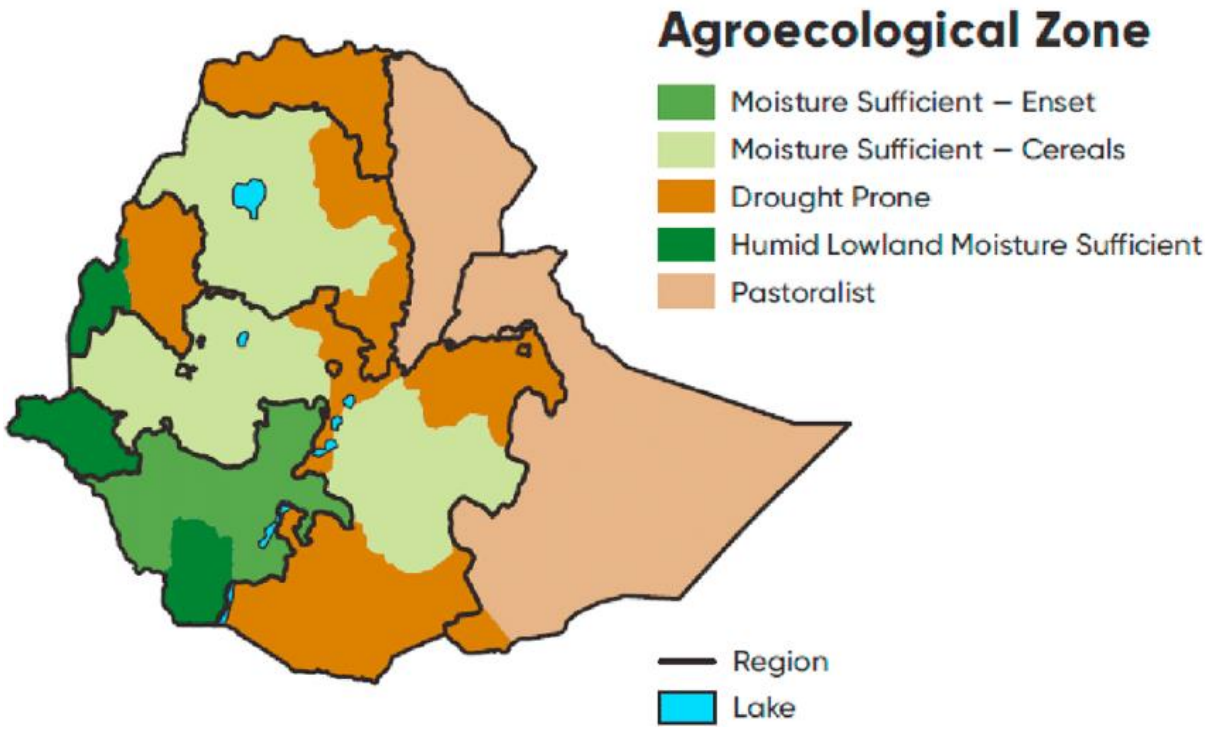


Figure 1: Agroecological zones of Ethiopia (Figure borrowed from Minten et al., 2018)

3.3 Biophysical challenges of Ethiopia's agroecological areas

Changes in land use and land cover are leading contributors to the decline and loss of ecosystem services over much of Ethiopia. A recent study demonstrated that the expansion of cropped areas has occurred at the expense of grassland, forest and shrub areas and that addressing degradation of land and water resources is crucial to reversing the loss of ecosystem services and achieving the national sustainable development goals related to food and water security and life on land (Mekuria, et al, 2021).

The major biophysical challenges across the agroecological areas and growing urban areas are outlined in Table 2 (EIAR, 2011).

Table 2: Main biophysical challenges across agroecological zones

Challenges	Lowlands	Midlands	Highlands	Humid areas	Urban areas[1]	Cause
	Bereha & Kolla	*Dega & Woina Dega*	*Wurch & Kur*			
Land degradation	***	***	**	*	*	
Soil erosion/ gullying	****	****	**	*	*	Poor conservation practices, loss in soil fertility and construction in urban areas
Soil fertility decline	**	****	**	**	-	
Soil salinity	****	**	-	-	-	Lowland areas of the Rift Valley and irrigated areas of Dega & Waina Dega
Soil Acidity	-	***	-	****	-	High rainfall areas
Soil pollution/ contamination	***	**	*	*	****	Industrial and residential waste
Effect of Climate change	****	***	**	**	*	Drought and flooding
Incidence of Pests and diseases	****	****	*	***	-	Poor agronomic practices
Land shortages and land grabbing	****	****	****	****	**	Due to development/ investment
Urban expansion	**	***	*	**	****	High competition for land
Weak waste management	-	*	-	**	****	High urban waste accumulation
Poor natural pastures	****	***	*	**	-	Free-range grazing
Agrobiodiversity decline	***	****	**	****		Investment, forest fire deforestation & climate change

Key: **** (very high), *** (high), ** (medium), * (low)

[1]Although urban areas are not part of any single agroecological zone, they are growing in significance in many areas.

3.4 How can agroecology help to resolve these challenges?

Agricultural development based on agroecological approaches can result in increased natural resource use efficiency, enhanced food security, increased biodiversity, improved resilience and better synergies as well as recognising and respecting local knowledge and practices.

Increased natural resource use efficiency: This can lead to reduced need for external inputs such as inorganic fertilisers and pesticides through recycling of plant residues and harnessing of biological processes to grow food. Reducing external inputs also reduces environmental and health hazards due to soil and water contamination.

Enhanced food security: Agroecological approaches are increasingly gaining importance due to benefits for sustainable development, food security and food sovereignty.

Increased biodiversity: The existence of all life forms in the soil is a sign of a healthy and fertile soil, one that grows healthy plants for human and animal use. Conservation of biodiversity and ecosystem services can be improved. For example, above-ground biomass diversity can help maintain and restore natural soil fertility, while below-ground biodiversity can increase microbial activity. Both are crucial for soil and crop health. Crop diversity reduces the risk of crop failure while increasing opportunities for co-existence and beneficial interaction between species that can enhance agro-ecosystem sustainability. Greater diversity also improves resource-use efficiency.

Improved resilience and synergies: Agroecological practices optimise interaction between plants, animals, humans and the environment. These build synergies increasing resilience and adaptation to climate change. Diversified systems can be efficient in capturing sunlight, in using rainfall and in mobilising and recycling nutrients, exhibiting close and efficient energy flows. At the same time natural ecosystems can self-regulate and result in a natural balance between pests and diseases, and their natural enemies. This can improve pest control and restore natural balances. Diverse crops, observed on many Ethiopian farms, can have several defence mechanisms that help protect them from pest and disease attack.

Respect and recognise local knowledge and practice: These can help to build food systems based on the culture, identity, tradition, innovation and local knowledge improving livelihoods and favouring social dynamics that focus on women and youth roles in agricultural development. Farmers and communities are at the heart of food production. Recognizing and supporting them as sustainable managers and guardians of natural and genetic resources helps in ensuring a fair and inclusive food system. Farmers and food producers need access to natural and genetic resources, including land and water through respecting customary use and a landscape approach to land governance at community level (FAO, 2017).

4 Understanding the scientific application of agroecology

4.1 Levels of Agroecological Integration

Agroecological transformation of agri-food systems takes place across five interlinked levels (Gliessman, 2016). These can be viewed as a continuous transition path from a baseline, which has little or no agro-ecological integration often associated with either modern conventional agriculture or degraded traditional farming systems. Levels 1-3 focus on the agroecosystem, involving changes that farmers can make themselves on their own farms. Levels 4 and 5 focus on the food system, going beyond agriculture to the entire food system and the communities in which they are embedded (Figure 2).

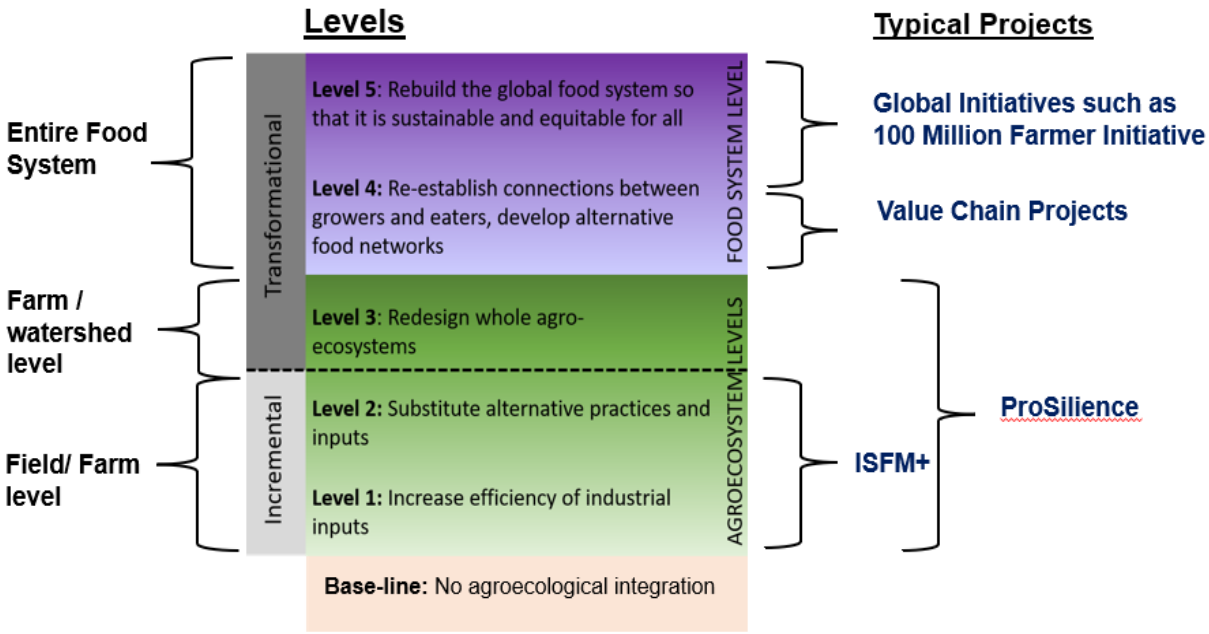


Figure 2: Levels of Agroecological Integration

More detailed descriptions of each level are:

- **Baseline:** Little or no agroecological integration occurs and the agroecosystem is negatively affected.
- **Level 1:** This aims to increase the efficiency of industrial inputs to reduce the use and consumption of costly, scarce, and environmentally damaging inputs for both modern agriculture and degraded traditional systems.
- **Level 2:** This aims to substitute or introduce alternative practices for industrial or conventional inputs and practices by reducing external input-intensive and environmentally degrading products and practices with those that are natural and environmentally sound and renewable.
- **Level 3**: This aims to redesign the agroecosystem so that it functions on a new set of ecological processes. The focus is primarily on the prevention of problems before they occur, rather than trying to control them after they happen.
- **Level 4:** This aims to re-establish a direct connection between those who grow food and those who consume it.
- **Level 5:** This aims to build a new global food system, based on equity, participation, democracy, and justice that is not only sustainable but helps restore and protects earth's life support systems upon which we all depend.

While levels 1-2 are incremental and applied at a field or farm level, Level 3 is transformational in nature and applied at a wider group of farms or watershed level. Levels 4 and 5 are transformational levels that go beyond the farm and watershed to the broader food system and the societies in which they are embedded (Gliessman, 2016; FAO, 2018) requiring linkages with others beyond the farm. These are not discussed in detail in this manual.

This manual focuses primarily on Levels 1-3, being those that can be implemented by farmers. In practice it is often difficult to determine which practice fits into which level as there are many overlaps depending on local circumstances. Two ongoing projects, ISFM+ is an example of a project operating primarily at Levels 1-2, while ProSilience operates across Levels 1-3.

4.2 Principles and aims guiding agroecological approaches

Agroecological approaches are based on 13 principles, which have emerged from recent work (Nicholls and Altieri, 2018; CIDSE, 2018; FAO, 2018; and HLPE 2019) and are an extension of 10 elements identified by FAO. The principles are interlinked and intertwined and can be used as a guide for policymakers, practitioners and stakeholders in planning, managing and evaluating agroecological transition and performance. These principles, when locally applied, generate diverse locally adapted agroecological practice through co-creation of knowledge with stakeholders. They can also be used to identify entry points for sustainable agri-food systems. The interrelation between these principles and the five transformation levels and their integration is shown in Figure 3.

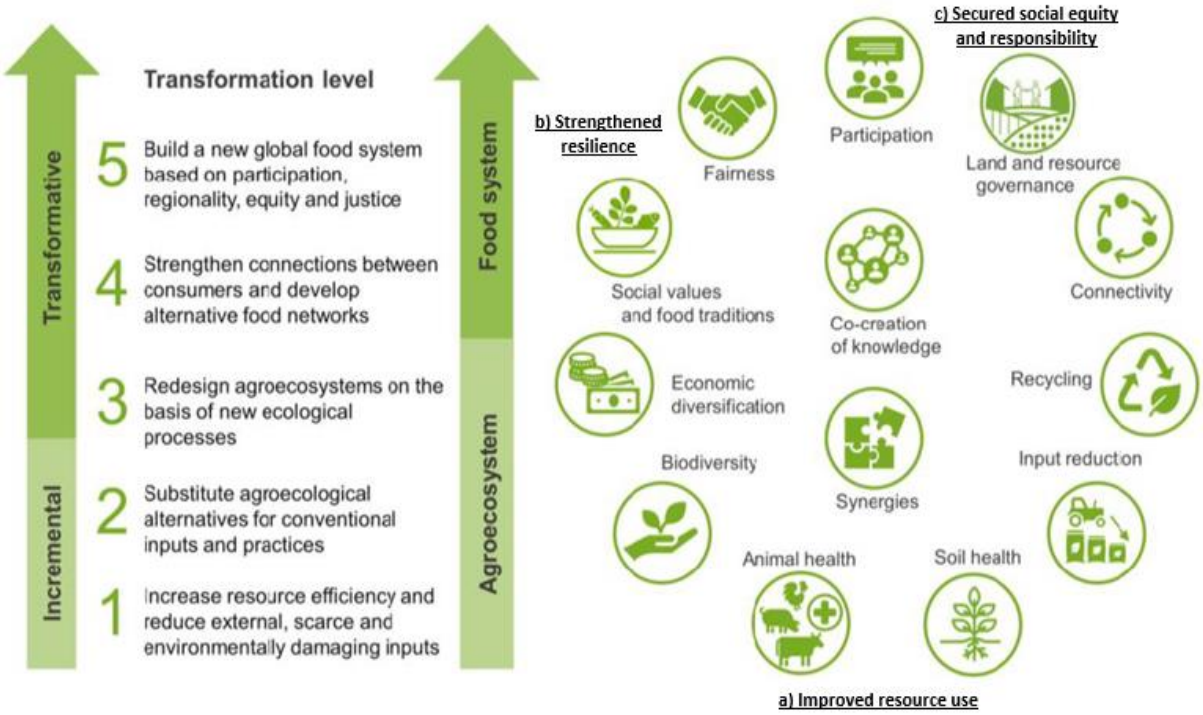


Figure 3: Agroecology's five levels, 13 Principles and three aims (Derived from Gliessman, 2016; FAO, 2018; and HLPE, 2019)

In guiding the transformation of food and agricultural systems each principle is related to one of three interlinked and interdependent aims. Although each agroecological principle has been allocated to the aim to which it most clearly contributes, this is not fully discrete. For example, principles 3 and 4 contribute not only to improved resource efficiency but also strengthened resilience. The three aims and the principles associated with each are:

a) **Improved resource efficiency:** recycling, input reduction, soil health and animal health.
b) **Strengthened resilience:** biodiversity, synergies and economic diversification.
c) **Secured social equity and responsibility:** co-creation and sharing of knowledge, social values and diets, fairness, connectivity, land and natural resource governance and most importantly participation. Many of these occur at an institutional level and may include a legal framework allowing their recognition and promotion. This is often reflected in participatory research and extension with public finances allocated to programmes or projects that encourage participants to produce and consume more sustainably.

A description of each principle related to each of the three aims showing their levels and scales of operation are shown in Table 3. Figures in italics relate to elements identified by FAO (2018).

Table 3: Agroecological principles by purpose showing the level and scale of application

Aims, principles and *elements*[1]		**Levels and Scales of application**
a) Improved resource efficiency		
1. Input reduction *Efficiency*	Reduce or eliminate dependency on purchased inputs and increase self-sufficiency	1 and 2 Field and Farm
2. Recycling *Recycling*	Use local renewable resources and improve nutrients and biomass recycling.	Levels 1 and 2 Field and Farm
3. Soil Health *Synergies*	Secure and enhance soil health and functioning for improved plant growth by managing organic matter and enhancing soil biological activity.	1 and 2 Field and Farm
4. Animal Health *Synergies*	Ensure animal health and welfare.	1 and 2 Field and Farm
b) Strengthened resilience		
5. Biodiversity *Diversity*	Maintain overall agroecosystem biodiversity at field, farm and landscape scales by enhancing or maintaining diversity of species, functional diversity and genetic resources	2 and 3 Farm and Watershed
6. Synergies *Synergies*	Enhance positive ecological interactions, synergies, integration and complementarity among the components of the agroecosystem (animals, crops, trees, soil and water).	2 and 3 Farm and Watershed
7. Economic diversification *Resilience*	Diversify on-farm incomes by ensuring that small-scale farmers have greater financial independence and value addition opportunities while enabling them to respond to demand from consumers.	2 and 3 Farm and Watershed
c) Secured social equity and responsibility		
8. Co-creation and sharing of knowledge *Co-creation and sharing of knowledge*	Enhance co-creation and sharing of knowledge including local and scientific innovation, especially through farmer-to-farmer exchange.	1, 2 and 3 Farm and Watershed
9. Social values and diets *Culture and food traditions*	Build food systems based on the culture, identity, tradition, social and gender equity of local communities that provide healthy, diversified, seasonally and culturally appropriate diets.	3, 4 and 5 Watershed and Food system

Aims, principles and *elements*[1]		Levels and Scales of application
10. Fairness *Human and social values*	Support dignified and robust livelihoods for all actors engaged in food systems, especially small-scale food producers, based on fair trade, fair employment and fair treatment of intellectual property rights.	4 and 5 Watershed and Food system
11. Connectivity *Circular and solidarity economy*	Ensure proximity and confidence between producers and consumers through promotion of fair and short distribution networks and by re-embedding food systems into local economies.	4 and 5 Watershed and Food system
12. Land and natural resource governance *Responsible governance*	Strengthen institutional arrangements to improve, including the recognition and support of farmers and food producers as sustainable managers of natural and genetic resources.	4 and 5 Watershed and Food system
13. Participation *Responsible governance*	Encourage social organization and greater participation in decision-making by food producers and consumers to support decentralized governance and local adaptive management of agricultural and food systems.	3, 4 and 5 Watershed and Food system
14.		

[1]Correspondence to FAO elements

Source: Adapted from Nicholls and Altieri, 2018; CIDSE, 2018; FAO, 2018; HLPE, 2019

Annex 1 provides a more detailed comparison of the agroecology frameworks of principles and elements.

4.3 ISFM and agroecology approaches

Integrated soil fertility management (ISFM) practices and technologies form an integral component of agroecology as shown on Figure 4, primarily at agroecology levels 1 and 2. ISFM aims at enhancing productivity through integrated soil health and fertility practices (GIZ and MOA, 2020) enabling a move from current practices (nutrient mining, insufficient soil organic matter, declining soil fertility and low yields) involving a stepwise process. This progresses through agroecology levels one and two and in the long term agroecological integration at both farm and watershed level is achieved.

- **Step 1 Quick wins:** including increasing on farm biomass production and introducing practices such as quality seed and improved crop management, addition of organic matter, targeted inorganic fertiliser and lime application, where necessary.
- **Step 2 Short-term:** In addition, reducing nutrient and biomass losses, ensuring sufficient soil organic matter and fertiliser, and introducing such practices as use of green manures and bio-slurry.
- **Step 3 Mid-term:** In addition, improving resource use efficiency, through introduction of practices such as Conservation Agriculture, double cropping including the use of green manures and cover crops, introduction of agro-forestry and rainwater harvesting techniques to further increase soil moisture and the use of bio-slurries.
- **Step 4 Long-term:** Agro-ecological integration at farm and watershed level can be achieved involving crops, pasture, livestock, and forestry resulting in reduced external input use with the farming system providing optimised productivity.

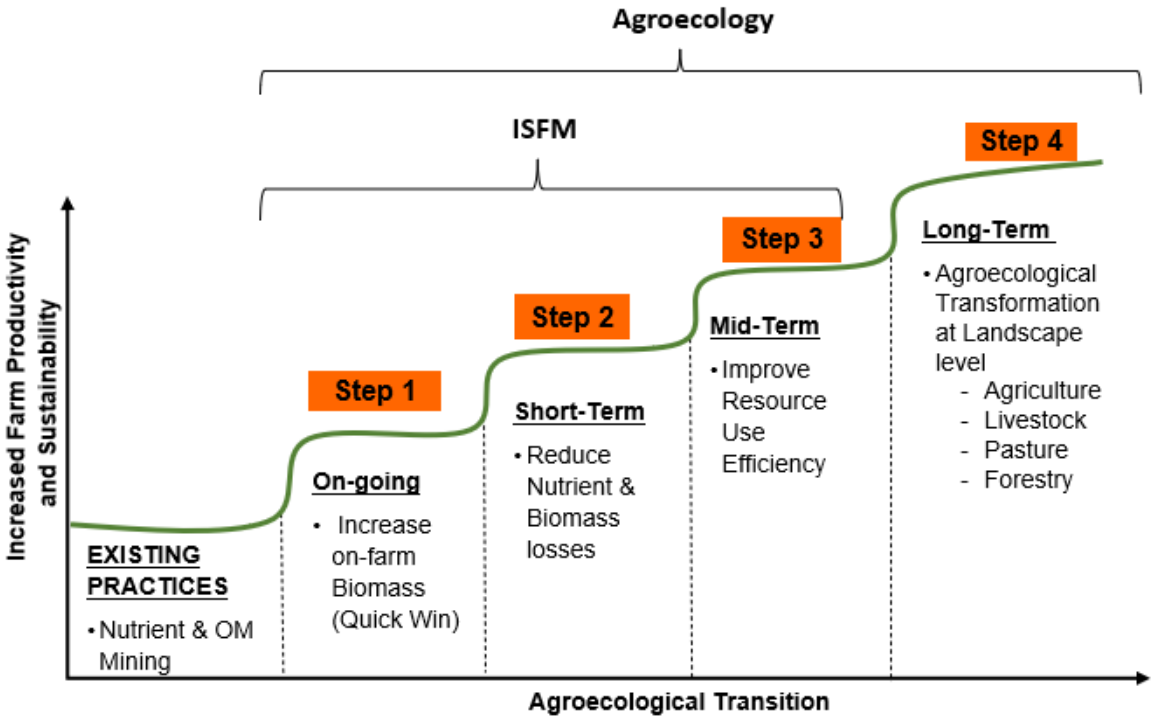


Figure 4: The ISFM-Agroecological continuum based on four stepwise approaches (Modified from Sanginga and Woolmer, 2009)

Responsive soils will show faster and greater increases in soil health, soil fertility and productivity than less responsive poor soils depending on soil type and climatic conditions. The efficiency of input and output markets will also contribute to productivity differences

5 Pathways towards sustainable agriculture in Ethiopia

5.1 Transition pathways for agricultural systems

Transition pathways combine technical interventions, investments and enabling policies, involving a variety of actors from different starting points. It is the three main aims and the 13 intertwined operational principles that shape these pathways (HLPE, 2019) with soil fertility management playing a key role.

Figure 5 shows two trajectories, one from traditional low input sometimes self-sufficient agriculture with low productivity but still negative impacts on the environment. The alternate trajectory starts from a conventional high input market orientated base, with high productivity but high negative impact on the environment. For both the baseline is little or no agroecological integration then moving up through levels one to three with initial emphasis placed on improving the efficiency of use of industrial inputs, then introducing environmentally friendly alternative inputs and practices until level three is reached when the agroecosystem is wholly redesigned. The contrast between the two starting points emphasizes the context-specific nature and the choices involved in taking different pathways. Moving from low input low output traditional practices can be viewed as smart intensification, while the change from high input high output conventional agriculture can be regarded as smart adaptation. Examples are provided for each of these levels in the next sections.

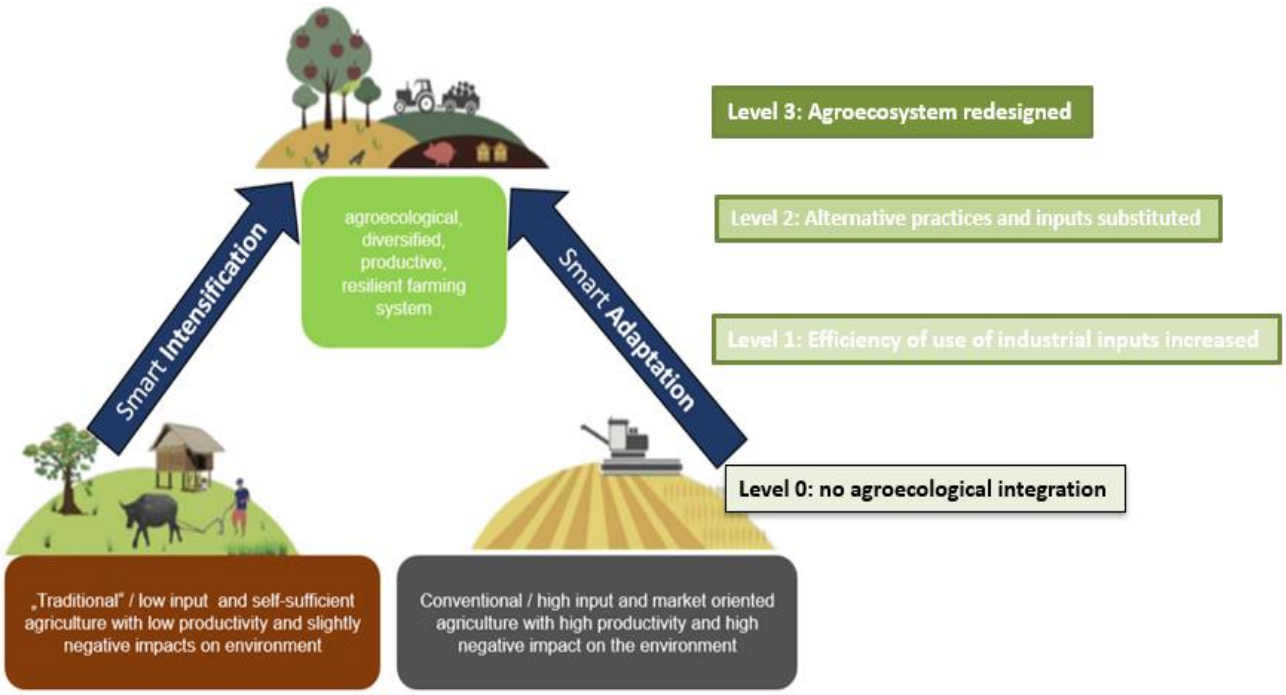


Figure 5: Alternate transition pathways for agricultural systems

Barriers to these transitions comprise five groups of interacting factors: i) knowledge; ii) resources; iii) markets and economics; iv) social and cultural factors; and v) governance.

Although there is a global consensus emerging around the transformation needed in agriculture and food systems, there is little agreement on which approaches should be promoted to foster this transformation. It should however be noted that moving from a traditional low input low output system to a conventional high input market orientated high output system is high cost and has a high negative input to the environment and is ultimately unsustainable.

5.2 Level 1 - Increasing the efficiency of use of industrial inputs

Level 1 practices aim to increase the efficiency of both low input traditional farming and conventional high input agricultural systems to reduce the use and consumption of costly, scarce, or environmentally damaging inputs. The relevant principle of agroecology is efficiency and includes all the inputs needed for crop and livestock production (seed, fertilizer, pesticides, energy including fuel, livestock types and numbers, animal feeds and veterinary products) as well as the agronomic and management practices with which they are used.

A good example is the use of nitrogen, essential in both crop and livestock production, which can be supplied as an inorganic fertiliser or through atmospheric nitrogen by leguminous plants. Figure 6 demonstrates nitrogen flows from the atmosphere to the soil, its use by plants as well as leaching losses. In this example maximising nitrogen fixation by legumes is preferable to use of N fertilisers.

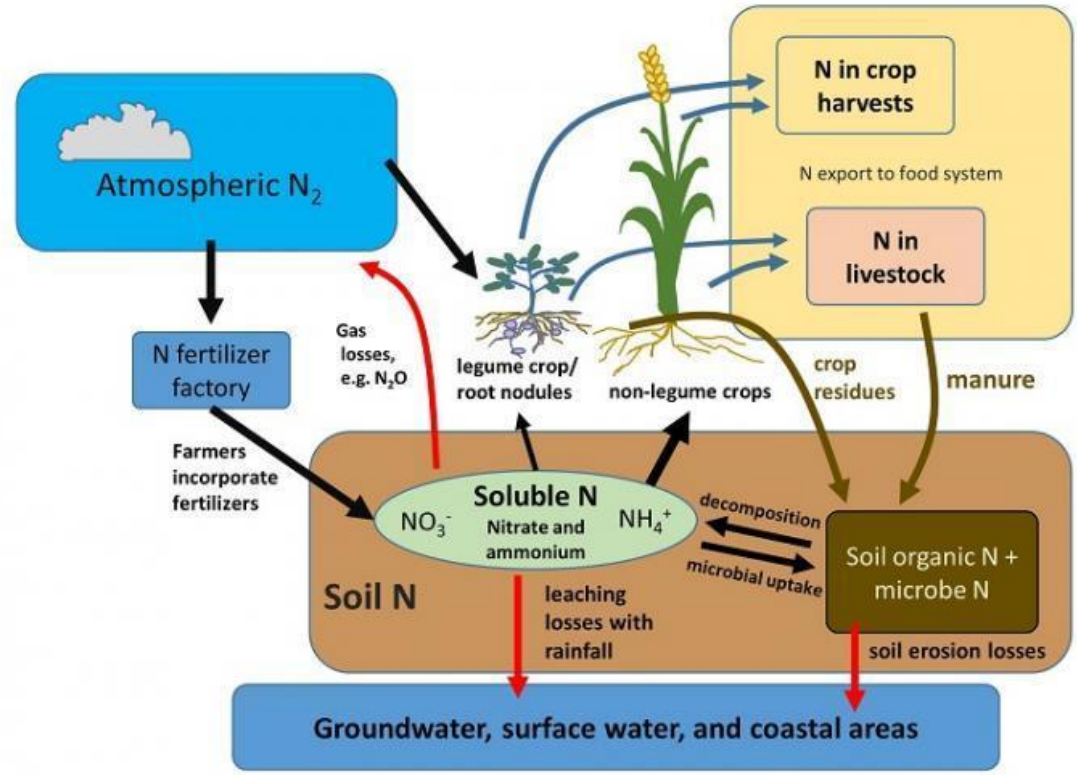


Figure 6: Nitrogen flows in an agroecosystem

Key nutrients which may need to be applied to the soil to correct deficiencies in the form of inorganic fertilisers include phosphate (P), Sulphur (S). Zinc (Zn) and Boron (B) as well as lime to counter soil acidity. In all cases soil analysis is desirable to identify the deficiency.

5.3 Level 2 - Substituting alternative practices

Level 2 practices aim to substitute or introduce alternative practices by reducing external input-intensive and environmentally degrading products and practices with those that are renewable. These are based on natural products that are more environmentally sound, the relevant principles of agroecology being recycling and balance.

5.4 Some examples of level 1 and 2 practices

Annex 2 provides typical activities for each of the 13 principles indicating the transition level and scale at which they can be applied. In practice it is often difficult to identify the level that a practice fits, as it can fit one or more levels. Some practices will be location specific and depend on the existing farming system, existing knowledge, agricultural training, community participation and local leadership. Some examples include increased farm biomass products, the use compost and manure, nitrogen-fixing legumes, cover crops and green manures and crop rotations all designed for improving soil health and increasing crop productivity.

Improving soil health: These include a variety of organic practices such as incorporating compost or manure, crop rotations, green manuring each of which allows efficient use or reduction in the use of inorganic fertilizers. In cases where soils are acid or essential nutrients are low, application of lime and appropriate fertiliser are likely to be required.

Vermicompost production
photo credit ISFM+

Compost heap
photo credit ISFM+

Application of compost and manure
photo credit ISFM+

Incorporation of a green manure crop
photo credit ISFM+

Application and incorporation of lime on an acid soil photo credit ISFM+

Other uses of organic matter include crop residues used as mulches, crops planted in small pits and use of fertiliser trees.

Well mulched maize field using crop residues
photo credit FARA

Maize planted in small pits and mulched
photo credit FARA

Maize stover left as a mulch
photo credit FARA

Maize-beans intercrop
photo credit ISFM++

Improved agronomic practices: Examples include use of improved seed for better crop growth, optimal seed spacing such as the System of Crop Intensification, the System of Rice Intensification, transplanting rather than direct sowing, and row planting rather than broadcasting.

Other examples include intercropping, relay cropping or diversified vegetable cropping each of which contributes to diversification.

Maize groundnuts intercrop
photo credit ISFM+

Diversified vegetable crops
photo credit Squarespace Images

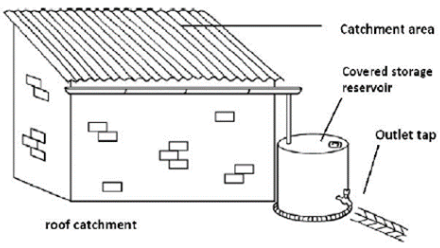
Soil conservation practices: These include stone walls, ditches, grass and sometimes hedge or tree barriers or combinations established along contour lines.

Ditches to collect rainwater runoff - photo credit ISFM+

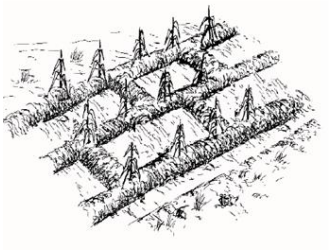
Stone wall and tree lucerne
photo credit: ILRI

Ditch and hedge - photo credit ISFM+

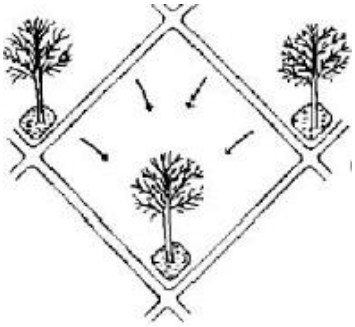
Reduced or improved use of water through improved soil conservation practices, such as rainwater harvesting (RWH) from roofs and micro-catchment areas as well as tied ridges between crop rows. Irrigation methods that require less water are also important.



Rooftop RWH



Tied ridges

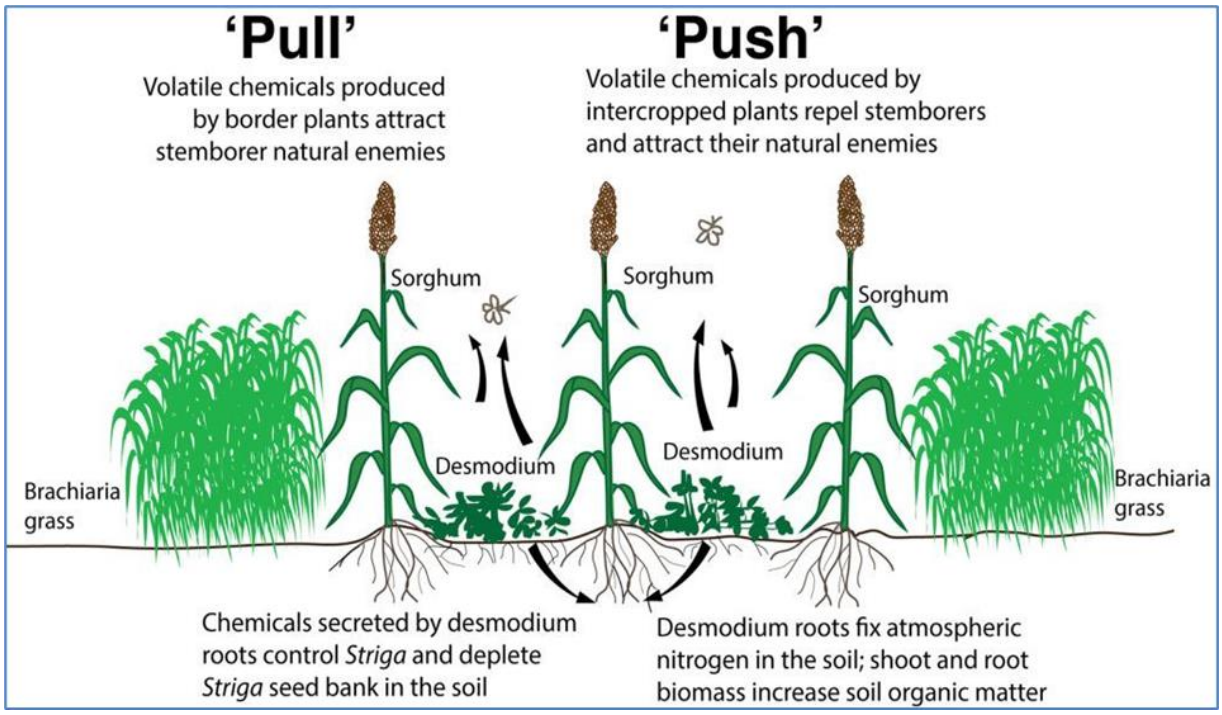


Micro-catchment for trees

Integrated Pest Management (IPM) is an approach that promotes preventative steps and reserves the use of chemical pesticides as a measure of last resort. Use of chemical pesticides carries with it serious environmental risks, including impacts on pollinators, insect eating birds and other vertebrates, and aquatic life. Numerous studies have shown that highly toxic pesticides kill natural enemies, including parasitoids and predators. The impact on natural enemies can be greater than on the pest, which can lead to pest populations rebounding after spraying. Long-term pesticide use can lead to an impoverishment of the natural enemy community and forces farmers to invest more and more in chemical pest control. There is a need for reduced application of herbicides, fungicides, insecticides, fumigants and use of veterinary drugs. Pests and diseases should preferably be managed through a variety of biological prevention measures with minimum chemical pesticides and drugs.

A good example of IPM is Push-pull, which can be described as a climate-smart innovation based on companion or inter-cropping, which addresses three constraints in cereal production, declining soil fertility, stem borer and *Striga*, while increasing grain yield without the use of external inorganic inputs. Push-pull is intended to provide continuous soil cover with a perennial cover crop and plant residue, as well as a diversified cereal-legume-fodder intercropping practice. The perennial intercrop provides live mulching, agro-biodiversity and a food web of natural enemies of stem borers (Khan et al, 2006; Midega et al, 2015). Furthermore, it improves soil health and conserves soil moisture. These companion plants release behaviour-modifying stimuli (plant chemicals) to manipulate the distribution and abundance of stem borers and beneficial insects for management of the pests (Figure 7). The system relies on an in-depth understanding of chemical ecology, agro-biodiversity, plant-plant and insect-plant interactions.

Figure 7: Push-Pull technology



Source: Khan et al, 2015

Push-pull involves intercropping cereal crops with a moth repellent forage legume *Desmodium* (the Push) and an attractive trap plant such as Napier or *Brachiaria* grass (the Pull) planted as a border crop around the intercrops. Stem borer females are repelled from the main crop and are simultaneously attracted to the trap crop (Cook et al, 2007). The companion plants can be valuable themselves as animal fodder, thereby facilitating livestock integration. *Desmodium* can also be

effective in suppressing the *Striga* weed, while improving soil fertility by fixing nitrogen and improving soil organic matter. Both companion plants can provide valuable fodder thus allowing integration of crop and livestock production. Use of drought tolerant *Brachiaria* and green leaf *Desmodium* as border and intercrop plants, provide effective control of stem borers and Striga, resulting in significant grain yield increases (Khan et al, 2014).

Use of locally produced feed for livestock: Since feed scarcity is a major constraint affecting livestock production due to dwindling natural pasture lands, growing cultivated forages has increasingly become a necessity to supplement available feed resources. The transition from free and open grazing to tethering of animals in restricted areas or backyards also requires adoption of cut-and-carry feeding practices. Forages that grow fast and can be harvested frequently for such feeding practices will be very important as a coping strategy in the foreseeable future. Mixing cultivated forages with crop residues is another strategy to improve the quality of the diet consumed in mixed farming systems. Home-grown cultivated forages and fodder trees have a considerable potential to replace commercial concentrate mixes.

Typical annual forages include Oats, Vetch, Cowpea, Lablab, Fodder beet. Typical perennials are Brachiaria grass, Desho grass, Napier grass, Alfalfa, Rhodes grass and tree lucerne, some of which are shown in the following pictures (Mekonnen, 2021).

Lablab cover crop
photo Credit: ILRI

Vetch underplanted a maize crop
photo credit: ILRI

Cowpea fodder
photo credit: ILRI

Zero-grazed goats
photo credit: A4D

Zero grazed dairy cows
photo credit: A4D

Cattle in silviculture-agroforestry
photo credit: Civil EatS

Alfalfa or lucerne - photo credit: ILRI

Napier grass - photo credit: ILRI

Integrated Crop Livestock Management Systems: These create synergies, making optimal use of resources with the waste products of one component serving as a resource for the other. For instance, manure from livestock is used to improve soil fertility and increase crop production, whilst crop residues and other biproducts, such as grass, weeds and processing waste, can provide supplementary feed for animals. Grass and pruning from agroforestry trees grown on conservation bunds and nitrogen-fixing legumes grown in improved crop rotations, are further potential sources of biomass and fodder. At the same time livestock provide traction and transport, as well as meat, milk and hides (Figure 8).

Figure 8: Integrated Crop Livestock Management Systems

Agroforestry: The integration of agroforestry in both cropping and livestock systems has a major role to play. It has the potential to support thousands of smallholder farmers in providing sustainable livelihoods, in achieving biodiversity targets and offsetting greenhouse gases. However, rights of farmers, ownership issues and water scarcity, along with insufficient extension and financial support are constraining factors that need to be addressed.

Fertiliser trees in a soybean field
photo credit: FARA

Tree lucerne for fodder or biomass transfer
photo credit ILRI

Sesbania trees for biomass transfer
photo credit ILRI

Use of waste products: Waste products from one activity or sector may serve as inputs to another, thus enhancing productivity and reducing pressure on ecosystem functions and services. A good example is bio-slurry. This is a mixture of manure and water in semi liquid form used as a feedstock for a bio-digester. It can be separated into liquid and solid fractions and stored separately, the solid fraction being stored in a similar manner to compost or FYM. It can be used or sold as a valuable fertilizer. The liquid component can be mixed in a 1:1 composition with water and applied directly to the soil around vegetables or fruit crops. In this form it is particularly beneficial for root vegetables, sugarcane, fruit trees, and for nursery seedlings. The solid fraction can be added to compost and used on field crops.

Bio-slurry production – photo credit ISFM+

Bio-slurry production – photo credit ISFM+

Other opportunities exist for on-farm enterprises maximising use of the environment or utilising waste products. Examples are honey production, aquaculture (fish) and small-scale poultry production each of which have their own strengths and challenges which go beyond the scope of this training manual.

Hives for honey production
Photo credit ISFM+

Aquaculture (fish production)
Photo credit A4D

Small scale poultry Photo credit unknown

5.4 Level 3 - Redesigning the agroecosystem as a new set of ecological processes

Level 3 involves a fundamental change in overall system design focusing on the prevention of problems before they occur, rather than trying to control them after they happen. The principles of agroecology related to this level are diversity, synergies and resilience.

5.5 Level 4 - Re-establishing connections between producers and consumers

Level 4 aims to re-establish a more direct connection between those who grow food and those who consume it. Food system transformation occurs within a cultural and economic context, and this transformation must promote the transition to more sustainable practices. At a local level, this means those who eat must value food that is locally grown and processed, and support with their cash the farmers who are attempting to move through Levels 1-3. Communities of growers and consumers can form alternative food networks around the world where a new culture and economy of food system sustainability is being built. Principles include co-creation of knowledge, culture and food traditions, and circular economy.

An important example is the current food “re-localisation” movement, with its growing networks of farmers’ markets, community-supported agriculture schemes, consumer cooperatives, and other more direct marketing arrangements that shorten the food chain.

5.6 Level 5 - Rebuilding the food system so that it is sustainable and equitable

Level 5 involves changes that are global in scope and reach beyond the food system to human culture, civilization, progress, and development. With Level 5 thinking and action, agroecology provides ways to build upon farm-scale and farmer-driven change processes to a full re-thinking of how we relate to each other and to the earth that supports us. Basic beliefs, values, and ethical systems change. The expanding awareness that is part of this process then extends to other facets of environmental and social relationships beyond food, bringing about a change in thinking focused on how the agriculture and food systems of the future can help reduce our ecological footprint, recognize that there are limits to growth, and what it means to live sustainably. Principles are human and social values and responsible governance.

The important role that food systems can and must play in mitigating and adapting to climate change as a global issue is one example of the value of Level 5 thinking. The growing food justice movement, where everyone in the food system enjoys the benefits of equity, justice, security, and sustainability, is another.

5.7 Planning, implementation monitoring and evaluation

The analytical frameworks described in the manual can be used not only for a guide for planning and implementation but also for monitoring and evaluating the performance of agroecological transitions. An analysis comparing different locations and different contexts can also support policy making on agroecology.

An Agroecology Criteria Tool (ACT) can be used to assess performance through the lens of agroecology. This shows the extent to which the project, program or policy is aligned with the various agroecology principles and elements (FAO, 2020). A further tool for agroecology performance evaluation (TAPE) is also available (FAO 2019b).

Annex 1: Comparison of agroecology frameworks of principles and elements

<table>
<tr><th colspan="2">System</th><th>Levels[1]</th><th>Aims[2]</th><th>Principles[2]</th><th>Elements[3]</th></tr>
<tr><td rowspan="6">Agroecosystem</td><td rowspan="3">Incremental</td><td>Level 1: Increase efficiency of industrial inputs</td><td rowspan="3">Improve resource efficiencies</td><td>1. Input reduction</td><td>1. Efficiency</td></tr>
<tr><td rowspan="2">Level 2: Substitute alternate practices</td><td>2. Recycling</td><td>2. Recycling</td></tr>
<tr><td>3. Soil health
4. Animal health</td><td rowspan="2">3. Synergies</td></tr>
<tr><td rowspan="5">Transformational</td><td rowspan="2">Level 3: Redesign whole agroecosystems</td><td rowspan="2">Strengthen resilience</td><td>5. Synergy</td></tr>
<tr><td>6. Biodiversity</td><td>4. Diversity</td></tr>
<tr><td rowspan="5">Food System</td><td rowspan="2">Level 4: Re-establish connections between growers and consumers, develop alternate food networks</td><td rowspan="4">Secure social equity</td><td>7. Economic diversification</td><td>5. Resilience</td></tr>
<tr><td>8. Co-creation of knowledge</td><td>6. Co-creation and sharing of knowledge</td></tr>
<tr><td rowspan="3">Level 5: Rebuild the food system</td><td>9. Social values and diets</td><td>7. Culture and food traditions</td></tr>
<tr><td>10. Connectivity</td><td>8. Circular and solidarity economy</td></tr>
<tr><td>11. Fairness</td><td>9. Human and social values</td></tr>
<tr><td colspan="2"></td><td colspan="2">12. Land and natural resource governance</td><td rowspan="2">10. Responsible governance</td></tr>
<tr><td colspan="2"></td><td colspan="2">13. Participation</td></tr>
</table>

[1]Gliessman, 2016; [2]HLPE, 2019; [3]FAO, 2018

Annex 2: Agroecological principles, *elements*[1] and typical activities

Aim A: Improve resource efficiencies

1. **Input reduction** (*Efficiency)* **- reduce dependency on purchased inputs** (seed, fertilizer, pesticide, water, energy

- **Improved crop/ plant varieties** that reduces the use of external inputs.
- **Reduced seed use:** improved or efficient storage and use of planting materials that result in better crop growth and reduced early mortality. Optimal seed spacing.
- **Reduced inorganic fertilizer application:** reduced application of fertilizer and nitrogen leakage. Improved monitoring, precision agriculture,
- **Reduced application of pesticides** (herbicides, fungicides, insecticides, fumigants. Plant varieties that reduce pesticide use. Integrated pest management (IPM) programmes. Improved monitoring, precision agriculture,
- **Reduced water consumption:** Drip irrigation, improved monitoring, precision agriculture, improved varietals, reduced wastewater.
- **Reduced harvest losses:** at harvesting, processing, storage or post-harvest through improved technologies and equipment. Timely harvest, improved storage facilities.
- **Reduced use of animal feed:** more efficient use of animal feed and veterinary drugs and vaccines that reduce the need for antibiotics.
- **Improved animal breed:** improved breeds that reduces the use of external inputs especially vet products.
- **Reduced energy use:** reducing fuel consumption in farming by improved technology, equipment or through renewable, low-carbon energy sources that can be used on farms (biofuels are rated separately). Energy-smart farming system relying on windmills, solar or photovoltaic panels, renewable energy-powered vehicles, renewable energy-powered equipment for water supply, distribution and purification, monitoring systems to reduce energy use, improved cooking stoves.

2. **Recycling** *(Recycling)* **- use local renewable resources by biomass recycling and improve nutrients**

- **Recycling of crop residues:** as a soil cover or for other uses, wood waste recycling for construction.
- **Recycling of wastewater:** recycling of agricultural and wastewater for agricultural use,
- **Use of biomass residues for energy generation:** energy derived from biomass residues: primary waste from harvesting residues, secondary waste from processing industries (e.g., using agro-forestry products) or from post-consumer residues and waste. Bioenergy from corn stalk, rice husk, slaughter waste, third generation biofuels, biogas from manure, Organic agricultural waste.
- **Climate mitigation through alternative practices:** adoption of practices that mitigate climate emissions by sequestering soil carbon or reducing GHG emissions. Increase soil carbon stock through reduced or no tillage, deep rooting plants.

3. **Soil health** *(Synergies*) **- enhance soil health for improved plant growth**

- **Crop rotations:** supporting a crop rotation system with at least three crops
- **Green manure:** cover crops or other plants that are left in the field to decompose, reducing dependence on inorganic fertilizers and increasing nitrogen fixation, or improving nutrient availability. Compost, manure, Nitrogen fixing cover crop and leguminous green manures, crop sown for mulch

[1] The 10 elements, closely aligned to these 13 principles, identified by FAO (2018) are show in Italics

- **Cover crops:** planting cover crops specifically to reduce erosion, run-off, increase soil organic matter, improve soil drainage, soil structure, alleviate soil compaction, improve overall soil condition/ Provide crop residues as a mulch to conserve soil moisture.
- **Reduced tillage:** adoption of minimum tillage or no-till practices. Direct seeding, strip tillage.
- **Perennial crops:** adoption of perennial plant species in place of annual crops, improved perennial varieties, general perennial grain crop program.
- **Use of biomass residues for energy generation:** energy derived from biomass residues: primary waste from harvesting residues, secondary waste from processing industries (e.g., using agro-forestry products) or from post-consumer residues and waste. This category includes energy generation from organic waste and residues only.

4. **Animal health** *(Synergies)* **- ensure animal health and welfare**
    - **Improved animal welfare and health:** improve livestock health and further efforts to support livestock well-being. Species-appropriate husbandry.

Aim B: Strengthen resilience

5. **Biodiversity** *(Diversity*) **- maintain overall agroecosystem biodiversity**
    - **Ecologically based crop rotations, multiple cropping, agroforestry and the integration of animals with crops.** Incorporating local and regionally adapted crops and animals.
    - **Improving Crop diversity:** Improving local seed and breed diversity, integrating locally adapted crops/races Spatially diversified farms, adoption of perennial plant species in place of annual crops.
    - **Improving local seed diversity:** supporting the development and promotion of local and regional varieties, including development of local varieties, local seed systems, seed banks
    - **Pest management:** through biological control methods that import, enhance or conserve pest enemies/antagonists (including predators, parasitoids, pathogens and competitors).
    - **Non-chemical pest management practices** that treat pest problems rather than preventing their occurrence, or biochemical pesticides that control pests by naturally occurring substance. Use of steam, UV treatments, LED lighting, insect sex pheromone, plant extract that attract insect pests to traps, neem spray, wood ashes.
    - **Spatially diversified farms:** encouraging diversity over space through inter-cropping.
    - **Enhancing functional agro biodiversitDear Mr. Argaw,vf5fcy**: protect or conservation forest fragments around agricultural fields, protect or enhance local and natural pollinators and their habitats.
    - **Landscape diversity:** diversity of all components living and working together - animal (domestic and wild); plant diversity (different strata); integration; etc.

6. **Synergies** (*Synergies*) **- enhance positive ecological interaction amongst the components of the agroecosystem**
    - **Integrated crop-livestock systems:** diversified farming system between plants, livestock, aquatic animals, trees, soils, water and other components including such system of rice intensification as fish-duck-rice system, silvopasture that optimise ecological functions and ecosystem service delivery.
    - **Agroforestry:** diversified farming system integrating crop production and trees Alley cropping with trees, coffee agroforestry.
    - **Non-crop plants:** incorporate non-crop plants in agroecological systems for ecological functions such as conservation, water quality or pest management. Use of weeds for food and forage in maize system.
    - **Rotational/regenerative grazing:** improved grazing methods/management to improve soil quality and forage yield. Grazing systems based on forage availability and demand.

- **Integrated pest management by habitat manipulation:** landscape planning or habitat management for biological pest control. Preserving or enhancing plant diversity or providing adequate refuge for pests' natural enemies.
- **Landscape planning and activity:** coordination of activities including land use and land at the landscape level that optimise ecosystem services that benefits agricultural production. Habitat conservation around agricultural lands, landscape-scale management interventions.
- **Reforestation and preservation of natural habitats:** diversified land-use at the landscape level with clear benefits for agricultural production. windbreaks, soil erosion control using hedgerows, terracing, stone bunds, contour bounding, rainwater harvesting.
- **Climate mitigation through redesigned system:** identifying or adopting practices that can mitigate climate change by sequestering soil carbon or reducing GHG emissions. Increase carbon stock through agroforestry.

7. **Economic diversification** *(Resilience)* **- diversify and protect on-farm incomes**
    - **Livelihood resilience and mechanisms to reduce vulnerability:** Diversification of work type, minimum indebtedness diversified income, production and access to market resilient against stress and shocks (e.g. economic, weather). and the capacity of farmers to respond to a disturbance and recover from it.
    - **Diversification of diets and consumption:** Diversification of crop production with a nutrition focus. Promotion of locally produced diversified healthy diets through a diversified food production system at the landscape and regional level.
    - **Resilience of agroecosystems to extreme weather events and other disturbances:** promotion of the resilience of agroecosystems to windfall, storm, heavy rain, winter freeze, floods, draught, wildfire. Developing frameworks to assess resilience of food systems and measuring the impact of management on the recovery of one or more ecosystem services in response to disturbance.
    - **Resilience and adaptive capacity to changing environmental conditions due to climate change:** research promoting resilience of agroecosystems to future conditions (salinity, average temperatures, new emerging pests and diseases), development of adapted system to future conditions Improved locally adapted varieties/breeds to future climate conditions.

Aim C: Secure social equity

8. **Co-creation and sharing of knowledge** (*Co-creation and sharing of knowledge*) **- including both local and scientific innovation**
    - **Connecting farmers to share knowledge**: engage farmers in co-creation and sharing of knowledge, integrate producer's knowledge and management experience through participatory research design and support for farmer-research-extension networks.

9. **Social values and diets** *(Culture and food traditions)* **- Build food systems based on the culture, identity, tradition, social and gender equity**
    - **Support healthy, diversified and culturally appropriate food traditions and diets:** build food systems based on the culture, identity, tradition, social and gender equity of local communities that provide healthy, diversified, seasonally and culturally appropriate diets, support and protect cultural identity and values tied to food systems.
    - **Support the right to adequate and culturally appropriate food:** support the ability of people to make decisions about the quality and type of food they gather, grow, hunt, fish and eat.

10. **Fairness** (*Human and social values*) **- dignified and robust livelihoods for all engaged in food systems, especially farmers**
    - **Gender and vulnerable group approach:** developing and informing policies and approaches that empower women or other vulnerable groups (including youth).
    - **Equity, dignity, inclusion:** support fair, dignified and inclusive livelihoods for all actors engaged in food systems, especially small-scale food producers.
    - **Support right to sufficient access to food**: developing and informing policies and approaches that ensure the right for people to feed themselves in dignity, implying that sufficient food is available, that people have the means to access it, and that it meets the individual's dietary needs.
    - **Promote food sovereignty:** developing and informing policies and approaches that allow communities to decide the way food is produced, traded and consumed.
    - **Creating jobs for rural youth based on agriculture**: developing policies and incentives for decent job creation.

11. **Connectivity** (*Circular and solidarity economy)* **- ensure proximity and confidence between producers and consumers**
    - **Business support for re-establishing the connection between producers and consumers:** assisting in the development of local food systems, short value chains and webs, developing trading relationships with local growers.
    - **Supporting regional value generation:** embedding food systems into local economies, connecting local producers with value-adding activities at the local or regional level, including post-harvest, processing, packaging.
    - **Encourage and sensitize for seasonal and regional demand**: action supporting a stronger seasonal and regional demand.

12. **Land and natural resource governance** *(Governance)* **- strengthen institutional arrangements including farmers as sustainable managers of natural and genetic resources.**
    - **Policy development on producer-consumer links:** developing or informing policies to help re-establish the connection between producers and consumers, market regulations allowing for branding of differentiated agroecological products.
    - **Inclusive policy making:** Develop or encourage policy-making that aim for sustainable and equitable food system.
    - **Establishment of equitable governance and rights over natural resources:** developing, informing or encouraging traditional and customary governance models, policies that ensure and protect equitable land tenure systems and secured access to natural resources.
    - **Policy development on the links between agroecology and global changes**: developing or informing policies on the integration of agroecology and other policy processes tackling global changes, such as climate change.
    - **Policy development that rewards agricultural management that enhances biodiversity and the provision of ecosystem services:** developing, informing and encouraging national level legislation, policies and programmes that protect biodiversity and multifunctional agriculture, subsidies and incentives for ecosystem services.

13. **Participation** *(Governance)* **- encourage social organization and greater participation in decision-making by food producers and consumers**
    - **Promote participatory and multi-stakeholder approaches in knowledge generation:** integrate farmers and other actors' views in all stage of decision-making, increase participation and exchange between different types of actors.
    - **Promote formal and non-formal "production and food" education:** support for farmer-education networks, formal and non-formal education.
    - **Strengthen organisational capacities:** increasing organisational capacities of farmers' communities and other local food system actors.

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