Food and Agriculture Organization of the United Nations

Report on the use of the **Tool for Agroecology Performance Evaluation (TAPE)** in Lesotho in the context of the Restoration of Landscape and Livelihoods Project (ROLL)

Results and analysis

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Acronyms and abbreviations

A-WEAI	Abbreviated Women's Empowerment in Agriculture Index
ASAP2	Adaptation for Smallholder Agriculture Programme
CAET	Characterization of the Agroecological Transition
EIF	Enhanced Integrated Framework
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
GVP	Gross Value of the (agropastoral) Production
IFAD	International Fund for Agricultural Development
LS	Livestock (expenditures for)
LSU	Livestock Unit
NGO	Non-Governmental Organization
NSA	FAO's Animal Production and Health Division
NSP	FAO's Plant Production and Protection Division
OCB	FAO's Office of Climate Change, Biodiversity and Environment
OFID	OPEC Fund for International Development
OPEC	Organization of the Petroleum Exporting Countries
ROLL	Restoration of Landscape and Livelihoods Project
RSDA	Rural Self-Help Development Association
SADP	Smallholder Agriculture Development Project
SDG	Sustainable Development Goals
TAPE	Tool for Agroecology Performance Evaluation
UNDP	United Nations Development Programme
USD	United States Dollar
VA	Value Added (of the agropastoral production)
WAMPP	Wool and Mohair Promotion Project
WEAI	Women's Empowerment in Agriculture Index

Acknowledgement

The present report is the results of the collaboration between the Food and Agriculture Organization of the United Nations (FAO), the International Fund for Agricultural Development (IFAD) and the Rural Self-Help Development Association (RSDA) for the implementation of the Tool for Agroecology Performance Evaluation (TAPE) in Lesotho. The study was funded by the second phase of IFAD's Adaptation for Smallholder Agriculture Programme (ASAP2).

This study could not be completed without the collaboration of 200 Basotho rural families who opened the doors of their farms and shared data about their production systems, way of life, marketing strategies, and social and cultural structure. The results of this study are intended to be used to improve their livelihoods and the overall sustainability of their farms through the support to IFAD's Restoration of Landscape and Livelihoods Project (ROLL) in Lesotho.

TAPE is jointly coordinated by the FAO divisions Animal Production and Health (NSA) and Plant Production and Protection (NSP). This report was redacted by Dario Lucantoni (FAO-NSA) in collaboration with 'Mampho Thulo and Lineo Makarabelo Makhoebe (RSDA), and with the support of Anne Mottet (FAO-NSA), Abram Bicksler, Franck Escobar, and Rassoul Sy (FAO-NSP).

The authors also acknowledge the support of Erica Doro, Hisham Zehni, Antonio Rota (IFAD), Molefi Mpheshea (FAO-OCB), the FAO Representation in Lesotho, and all RSDA's staff in Lesotho.

Executive summary

As agroecology has increasingly been brought into the international dialogue on the future of food and agriculture, there have been calls for building the evidence base of its performance across the multiple dimensions of sustainability and its capacity to achieve multiple SDGs. In response to this need, FAO coordinated the participatory development of the Tool for Agroecology Performance Evaluation (TAPE), whose general objective is to produce consolidated evidence on the extent and contextual use of agroecological practices and the performance of agroecological systems globally.

TAPE is an innovative and holistic framework and process that can support projects (among other uses) to include an agroecological approach to ensure that transformational contextualized practices for regenerated landscapes and sustainable livelihoods are developed and spread throughout targeted areas. TAPE has already been tested in more than 30 countries by different actors for different purposes and has recently been used to support IFAD's Regeneration of Landscapes and Livelihoods (ROLL) project development in Lesotho.

In this document, the results of the implementation of TAPE in Lesotho for the baseline assessment of the ROLL project are presented. The framework was implemented in 200 production systems across 4 agro-ecological zones, 5 districts and 19 distinct landscapes. The use of TAPE in these territories provided important data and key information about the overall sustainability of farms measured by different indicators of performance. It also provided insights on how the level of agroecological transition measured with the 10 Elements of Agroecology links with the multidimensional performance of the evaluated systems.

This study is divided into 6 Chapters: Chapter 1 provides a contextualization of agriculture and food systems in Lesotho and presents the ROLL project's objectives in the country; Chapter 2 describes the sampling strategy and defines the typologies of production systems identified in the target areas; Chapter 3 characterizes the level of agroecological transition in Lesotho; Chapter 4 provides evidence on how more advanced agroecological systems in the country are more productive and more resilient, even if there is room for advancing in the process of transition for increased overall sustainability; Chapter 5 summarizes the findings of the study; and Chapter 6 provides suggestions and recommendations on how and why the ROLL project can and should support the different processes of agroecological transition in Lesotho through specific context-relevant interventions identified by the TAPE tool and its process of use.

1. Introduction

Lesotho is a landlocked country entirely surrounded by South Africa. It covers an area of 30 000 km² and has a population of about 2 million. The country is situated at the highest part of the Drakensburg escarpment, with altitude ranging from 1 500 to 3 482 meters above the sea level and is divided into ten administrative districts and four agro-ecological zones: i) Lowlands, ii) Foothills, iii) Senqu River Valley, and iv) Highlands (cf. Figure 1).

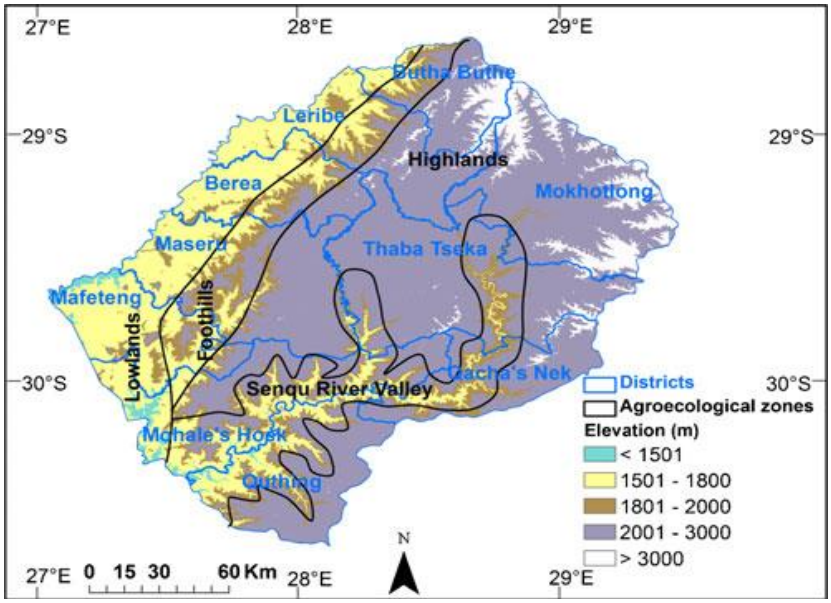


Figure 1: Map of the 4 agro-ecological zones and the 10 districts of Lesotho (Chakela, 1999)

Lesotho is considered the water tower of Southern Africa and agriculture is the backbone of the local economy. The agricultural sector is dominated by smallholder subsistence production, with reliance on rain fed, low input/output production methods with average low yields and widespread poverty in rural areas. Most farming households produce for their own consumption and raise animals together in mixed production systems.

Population growth, environmental degradation, poverty, climate change and food insecurity have forced people into previously uninhabited areas like wetlands and mountain slopes. This has contributed to higher pressure on local resources, unsustainable practices in land use, loss of local customs and ancient traditions. As a result, the country has suffered severe land degradation that threatens traditional herding culture and livelihoods.

Crop production is dominated by maize (65 percent of the area under cropping), sorghum (25 percent), and wheat (12 percent), while legumes have much lower numbers (5 and 3 percent respectively) (GEF7, 2020). Maize is the basic staple food crop of the people as it contributes 40 percent to the daily diet. Sorghum is the next important cereal used in preparation of porridge, traditional beer brewing and preparation of animal feed. Beans and peas have been grown for long as cash crops and are major sources of protein in the local diet. The areas under cultivation, production, and yields are very erratic and closely related to rainfall patterns. Other factors such as soil infertility, inadequate use of organic fertilizers, inefficient technologies that are characterized by untimely planting, poor land preparations inadequate weeding, and delayed harvesting are also major factors that greatly affect crop production in Lesotho.

Animal production is dominated by sheep, cattle, and goats raised extensively on communal rangeland. Cattle are mainly used for subsistence which includes draught power, milk, fuel sources, socio-cultural uses and ceremonies. Sheep and goats are raised for their wool, slaughter and for ceremonial purposes. Livestock herd sizes are mainly controlled by natural factors such as fertility and mortality rather than planned management. Overstocking, and the resulting overgrazing, is recognized as one of the key contributing factors to land degradation in Lesotho.

The domestic production of fruits and vegetables is a source of livelihood for at least 10 percent of the population in the foothills, lowlands, and Senqu River Valley. However, this potential has been marginalized by skewed climate extremes and hazards such as hail, frost, and extreme temperatures, which could even become more severe under climate change conditions.

In recent years, the country has shown significant potential in horticulture, with main products being fresh fruits and vegetables. While they are primarily produced by smallholders for subsistence consumption, and where most output is owner consumed, distributed to neighbors or sold in informal domestic market.

Climate in Lesotho is temperate with cool to cold winters and hot, wet summers. Mean annual rainfall is 788 mm and varies from less than 300 mm in the western lowlands to 1 600 mm in the northeastern highlands. There is substantial seasonal distribution of precipitation and as much as 85 percent of the total rainfall can be received during October to April (FAO, 2016). Highlands usually receive the highest rainfall but have a shorter cropping season due to the early onset of frost and the presence of snow during winter.

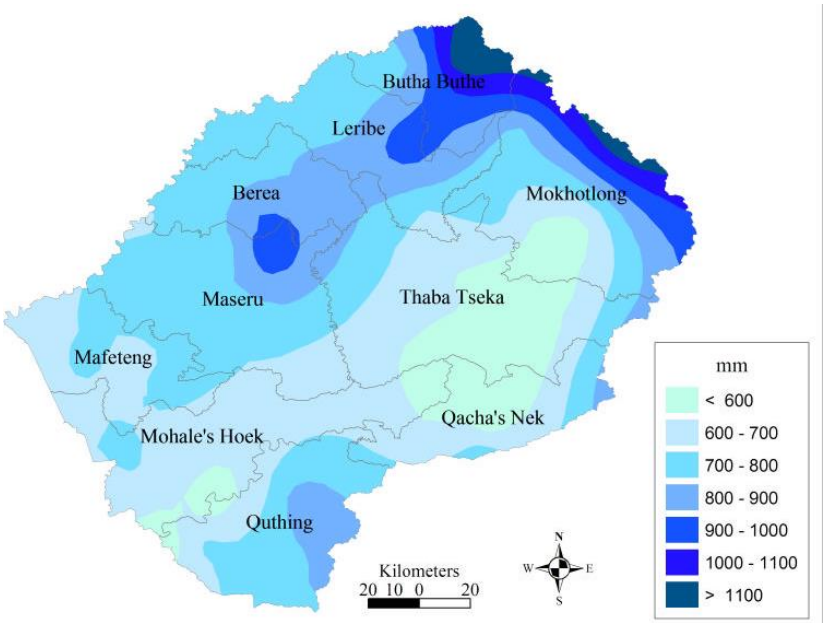


Figure 2: Map of average annual precipitation in Lesotho (Moeletsi and Walker 2013)

Temperatures are greatly variable, on daytime, monthly and annual time scales. Normal winter minimum temperatures range from -6.3 °C in the mountains to 5.1 °C in the lowlands on monthly bases. However, extremes of monthly mean winter minimum temperatures of -10.7 °C can be reached, and daily winter minimum temperatures can drop as low as -21 °C at some places in the mountains. Subzero daily minimum temperatures can be reached even in summer, both in the lowlands and the mountains. January is the hottest month with maximum daytime temperatures exceeding 30 °C in the lowlands (FAO, 2016).

Short seasons characterized by early frost, snowfall and extremely cold conditions are unsuitable for maize, which is the major staple food for most parts of the mountain districts.

The recent COVID-19 pandemic had very negative impact on the economy, jeopardizing livelihoods and adding to existing structural and macroeconomic issues. A study carried by UNDP (2020) assessed the economic situation in 2020, and the impact of the pandemic on the various sectors of the economy. For agriculture, erratic rainfall and above average temperatures between end 2019 and March 2020 have further increased likelihood of reduced harvest and with more than 500 000 people (out of which 85 percent were in rural areas) at risk of food insecurity due to the negative effects of the pandemics.

Image 1: Local farmer with maize production in front of traditional house.

1.1 Description of Lesotho's agro-ecological zones

Lowlands are comprised between 1 500 and 1 800 meters above sea level. The climate allows the production of maize, sorghum, beans, pea, wheat, potatoes and vegetables. The most common livestock enterprises are piggery, dairy cows, and poultry. These products are normally sold to individuals, supermarkets in towns, local shops, and dairy processing plants for milk.

The majority of farmers in the area are smallholders. Vegetable production is another common enterprise especially in places that are near sources of water. The most commonly grown vegetables are brassicas, carrots, tomatoes, beetroot and the peppers.

Tunnels and shade nets are common sight as a result of IFAD's projects like the Smallholder Agriculture Development Project (SADP) and the Enhanced Integrated Framework (EIF) under the Ministry of Trade and Industry Lesotho.

Fruit tree production is also very common and the most popular trees in Lesotho are peaches, apples, pears, apricots and grapes.

Foothills are comprised between 1 800 to 2 400 meters above sea level.

Most common crops in the area are maize, sorghum, beans, pea, wheat, potatoes and vegetables. Crop production is often for self-consumption only. There are few smallholder farmers engaged in horticultural commercial production.

Farmers mostly use tractors for ploughing and cattle for pulling cultivators for removing inter row weeds in row field crops. Sheep and goat production is still common but not widespread as in the mountains. Animals normally graze pastures dominated by shrubs.

The zone of foothills is most suited for fruit production. Fruits from this region are free from pests and diseases and mature late when the fruits in the lowlands are finished fetching good price for the farmers. Farmers usually sell them to the neighboring lowlands towns. Farmers do not necessarily own well-managed orchards, but rather trees grown in the gardens with other crops or along the contours in the fields.

The IFAD funded Wool and Mohair Promotion Project (WAMPP) carried out by the Government of Lesotho assists farmers in sheep and goat production (see more the details in the Highlands zone). The Smallholder Agricultural Development Project (SADP) provides farmers' groups and individuals with shade nets, tunnels, irrigation equipment, boreholes, piggery, poultry, sheep breeding stock and production structures. Farmers also have access to the agricultural inputs subsidy program that provides fertilizers, seeds and pesticides at subsidized costs.

The **Senqu River Valley** is a steep basin along the Senqu River, which runs from east to west across the country. The valley is characterized by low rainfall and relatively higher temperatures than in the mountain areas.

Typical crops of this are winter wheat, maize, sorghum, and fruit trees, which normally give better yields than in the mountains.

Livestock farmers from this region keep their animals in the mountain regions and normally bring them back during the winter season to avoid very cold and snowy conditions at higher elevations.

Highlands constitute the largest part of the country (57 percent of the surface) and in characterized by abundance of water. This zone is comprised between 2 400 up to 3 500 meters above sea level and characterized by chilly winters.

Livestock production is the main productive activity of this area: sheep and goats are graze in rangelands mainly to produce wool and mohair, which are major contributors to GDP in the agricultural sector. Old animals or those not useful for breeding are also butchered and consumed.

In these areas too, WAMPP is assisting farmers with improving the quality of breeds reared for production of wool and mohair, reducing over stocking in rangelands by giving farmers quality ram or buck in exchange for poor quality individuals. The project also promotes supplementary feeding by subsidizing feeds for the farmers.

Cattle are also important in the mountains for ploughing, since most of the fields are located on sloppy areas that are inaccessible to tractors.

Farmers also grow a variety of crops, but the most successful ones in this region are potatoes and wheat.

Image 2: Local herder with sheep in a mountain landscape.

1.2 The ROLL project in Lesotho

FAO's support to IFAD in Lesotho targeted the Regeneration of Landscapes and Livelihoods (ROLL) project. ROLL is a project funded by IFAD, the OPEC Fund for International Development (OFID) and the Government of Lesotho (GoL), with additional GEF resources. The total funding for the project is USD 46 million with an implementation period of eight years (2021-2028) (IFAD, 2021).

ROLL development objective is to ensure rural communities in Lesotho adopt transformational practices for regenerated landscapes and sustainable livelihoods. This is underpinned by four outcomes, namely: i) **changed resource use practices**, ii) the **reduction of environmental degradation**, iii) **improved livelihoods**, and iv) a **facility and fund being established**. The strategy emphasises the importance of finding effective and efficient means to achieve these outcomes in the long term, fostering a concerted effort of governmental and non-governmental actors. ROLL is also the primary baseline project for the Global Environment Facility (GEF) 7 Trust Fund – known as ROLL-GEF (IFAD, 2020). ROLL GEF has three interlinked components: i) **Enhanced capacity in integrated landscape management**; ii) **landscape restoration**; and iii) **knowledge management, monitoring and evaluation**.

Image 3: Local farmer with maize production.

A list of 19 landscapes directly associated with villages within 16 sub-catchments in five districts of Lesotho were selected for project start-up (IFAD, 2021) (Figure 3). The 5 districts are: Thaba-Tseka, Leribe, Berea, Qacha's Nek and Botha-Bothe. Within the five districts, the project will target approximately 1 000 villages, and within each village one coalition and approximately 4 groups (grazing associations, women saving groups, herder groups, others). While the village will be the entry point for community mobilization, coalitions may also be formed and/or supported at higher, inter-village level, depending on the specific environmental and institutional characteristics of each landscape.

About 100 000 persons will directly receive project services, corresponding to approximately 68 000 rural households. The average rural household in Lesotho has five members, meaning ROLL is expected to reach a total of 340 000 people (household members).

The target group are vulnerable rural households who live in these selected catchment areas. They will comprise small-scale producers including poor smallholder farmers, livestock owners and herders, together with unemployed youth and wage laborers. The great majority of these households keep livestock (1-2 animals) and grow mainly maize (on about 0.7–1.5 hectares of land), with casual labor contributing between 15 and 30 percent of annual income. For most of these households, accessible, resilient and productive rangelands are a prerequisite condition for increasing their assets and productivity and lifting themselves out of poverty.

The use of the FAO "Tool for Agroecology Performance Evaluation" (TAPE) in the context of the ROLL project was meant to help include an agroecological approach in the project formulation and implementation that ensures that transformational practices for regenerated landscapes and sustainable livelihoods are adopted and spread throughout the targeted areas. A detailed explanation on how the tool is applied to the project is provided below.

2. Methodology

TAPE, the "**Tool for Agroecology Performance Evaluation**" (FAO, 2019), is an analytical framework developed by FAO and based on various existing methodologies for assessing sustainability in agriculture. It uses agroecology to measure the multi-dimensional performance of production systems in agriculture (Mottet et al., 2020).

Before the deployment of the fully-fledged methodology, Step 0 consists in a desk review to contextualize the territories of the study. In this report, ROLL's project documents have been extensively used for this purpose.

TAPE's Step 1 is known as the "**Characterization of the Agroecological Transition**" (**CAET**). It is based on the 10 elements of agroecology[1] (FAO, 2018), which are disaggregated into 36 indices (cf. Table 8) that also cover the 13 principles of agroecology[2] (HLPE, 2019). Each index has a descriptive scale with 5 levels of transition (scores from 0 to 4) that are used to calculate the percentage of agroecological transition for each element and hence the overall score of transition (CAET).

TAPE's Step 2 is based on **10 core criteria of performance**[3] to measure the performance of the different types of systems across various dimensions of sustainability (economic, environmental, social) which are strictly linked to the SDGs.

Image 4: RSDA staff interviewing a local farmer for collecting data with the TAPE survey.

Data for Step 1 and for Step 2 are collected in the field during an interview with the producers selected with the sampling method applied.

[1] Diversity, Synergies, Recycling, Efficiency, Resilience, Culture & food traditions, Co-creation & sharing of knowledge, Human & social values, Circular & solidarity economy, Responsible governance.

[2] Recycling, Input reduction, Soil health, Animal health, Biodiversity, Synergy, Economic diversification, Co-creation of knowledge, Social values and diets, Fairness, Connectivity, Land and natural resources governance, Participation.

[3] Land tenure, Productivity, Value added, Income, Use of pesticides, Dietary diversity, Women's empowerment, Youth empowerment, Agrobiodiversity, Soil health.

A letter of agreement between FAO and Basotho NGO "Rural Self-Help Development Association" (RSDA) was signed for the work of data collection in the selected territories of the country. Enumerators for data collection are experienced staff selected by RSDA and trained by FAO in the use of TAPE in the field with the support of KoBoToolbox, an online data collection tool.

After data collection and in agreement with RSDA, 6 out of 36 CAET's indices have been calibrated by assigning them different weights to better reflect the reality of agroecological transitions and the significance of the 10 elements of agroecology in the specific context of ROLL in Lesotho.

Applying different weights to indices of Step 1 CAET is a possibility given to TAPE users to better fit the tool to the local context based on their experience and knowledge of the territories and producers. All indices are normally considered important in the total calculation of each element, but their weight can be doubled or halved if the indices are considered crucial or less important. For this study, 6 indices in 4 elements were weighted, namely:

- "Productivity and household's needs": weight doubled in order to better reflect the importance of overall agropastoral productivity in the element of Efficiency;
- "Recycling of biomass and nutrients": weight double in order to better reflect the importance of recycling of animal manure and byproducts of the agricultural production in the element of Recycling;
- "Water saving": weight halved to reflect the relative abundance of water in the area, which makes strategies and techniques for water harvesting and saving less important for the calculation of the element of Recycling;
- "Appropriate diet and nutrition awareness": weight double to better catch households' food security in the element of Culture & food traditions;
- "Local or traditional identity and awareness": weight halved in order to focus the result of the element of Culture & food traditions more on food security and less on culture;
- "Animal welfare": weight halved to better capture the social and labor conditions of humans in the element of Human & social values.

2.1 Data collection

TAPE was used to evaluate 200 households in Lesotho. The data collection took place in June and July 2021, lasted roughly 4 weeks, and 7 enumerators were involved in the data collection. On average, each enumerator conducted 29 farm interviews.

The survey was conducted in 19 sub-catchments (or landscapes) of the 5 districts of Thaba-Tseka, Leribe, Berea, Qacha's Nek and Botha-Bothe. The landscapes were provided by IFAD and their location is shown on a map in Figure 3, as well as the number of households interviewed in each landscape.

Interviewed producers were selected with the help of local networks under the mentorship of RSDA and the governmental extensionists from the Agricultural Resource Centers in each target landscapes. Selection was based on the most active and/or prominent farmers in the villages in selected landscapes. The lists provided by the farmers' groups and extension staff were combined and the interviewees were selected randomly.

District	Landscapes	Sub-catchment	#
Berea	Ha Nts'ang	CC 60	12
	Nchela-Matholoana	CC 23	16
	Lekokoaneng-Souru	CC23	16
	Mamatebele	CC 13	12
Leribe	T'soinyane	SC 9	10
	Koasa Mphosong	CC 6	8
	Lejone-Matsoku	CC 17	8
Botha Bothe	Qholaqhoe	CC 65	10
	Marakabei-Hololo	CC 63	8
	Motsinkaneng	SC 03	8
	Matsoku	SC11	12
Thaba Tseka	Mants'onyane	SC 28	8
	Litsoetse	SC 35	8
	Mashai	SC 35	12
	Khohlo Nt'so	SC 30	12
Qacha's Nek	Matee	SC 47	8
	Mosuoe	SC 40	12
	Milikane	SC 48	8
	Mapakising	SC 40	12
Total			200

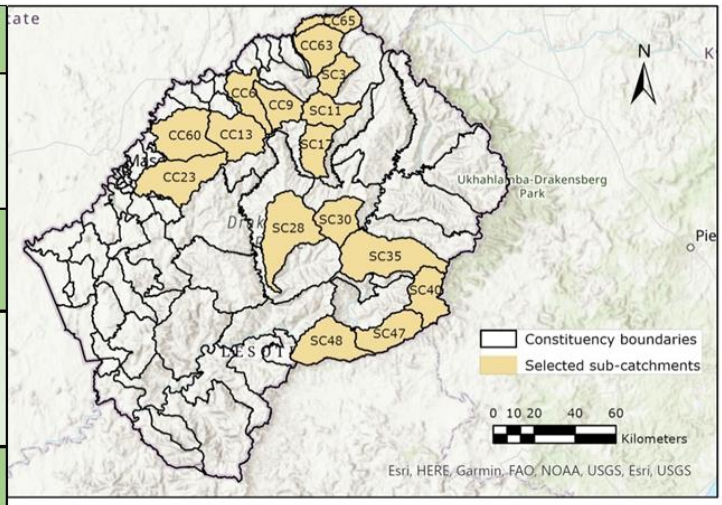


Figure 3: Distribution of respondents by district, landscapes, sub-catchments and map of the target territories (GEF7, 2020)

2.2 Selection of typologies for evaluation

For the analysis of the results, TAPE's Step 1-bis allows the definition of typologies (FAO, 2019) for a deeper analysis of the results. For this study, three groups of typologies were defined:

1. The **CAET typology** - using the scheme proposed in Lucantoni et al. (2021) for categorizing agroecological transition, systems having a CAET score lower than 50% are considered "**non-agroecological**"; systems with a CAET score comprised between 50% and 60% are considered in "**incipient transition**"; systems with a CAET score comprised between 60% and 70% are considered "**in transition to agroecology**"; while systems having a CAET score higher than 70% are considered "**agroecological**". Since only one farm belongs to this latter category (0.5% of the sample), it has been included into the category in transition. Because of the high number of farms having a CAET lower than 50%, the category of non-agroecological farms has been split in three (CAET 40-50%, CAET 30-40%, and CAET <30%).
2. The **geographical typology** - evaluated systems are categorized according to their locations within the four agro-ecological zones of Lesotho: **Lowlands**, **Foothills**, **Senqu River Valley**, and **Highlands**.
3. The **typology of production systems** – three types of production systems were identified in Step 0:
   - **Monoculture:** farms centered on the production of one main crop (mostly maize or sorghum) that might have other smaller production (horticulture or small-scale livestock).
   - **Crops and livestock**: the most common type found in the country: any farm producing more than one main crop plus some livestock. Main crops could be cereals (maize, wheat, sorghum), legumes (beans, peas), or vegetables.
   - **Diversified farms (crops, livestock, and horticulture)**: the most diversified type in Lesotho produces more than one main crop, plus vegetables and livestock species.

2.2.1 Size of productive systems and use of land

The great majority of the production systems evaluated are smallholder farmers (88 percent with less than 5 ha), which are the most common farmers found in the country. 45 percent of the sample has less than 2 hectares.

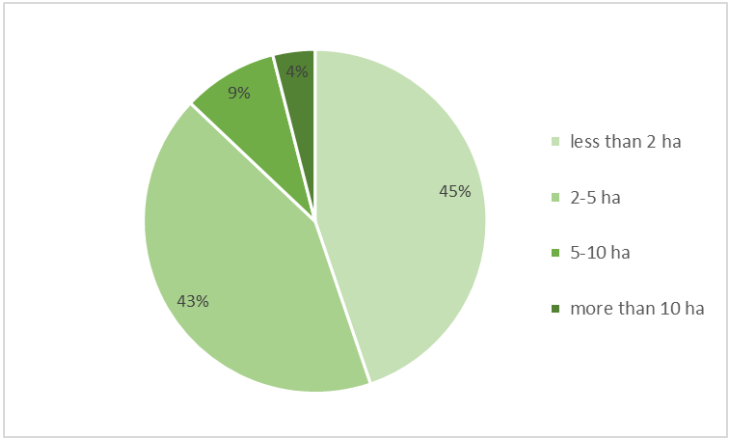
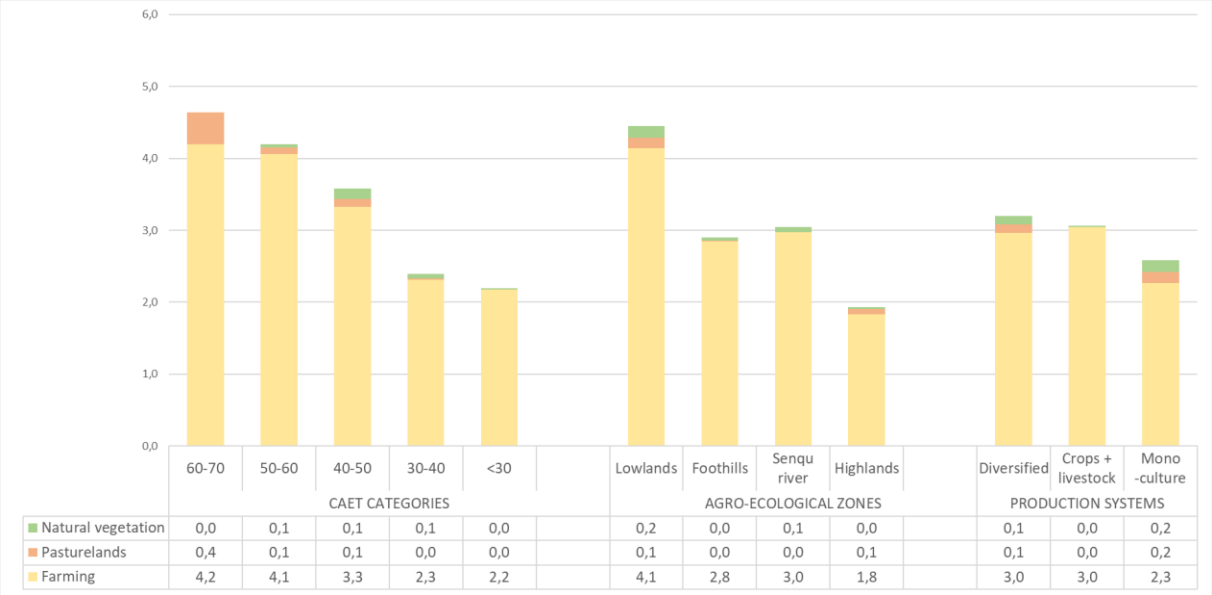


Figure 4: Relative distribution of farms per surface in hectares.

Figure 5 presents the average size of evaluated Systems and the use of land per typology. In 99 percent of the observations, areas under natural vegetation or owned for private pasturelands are negligible.



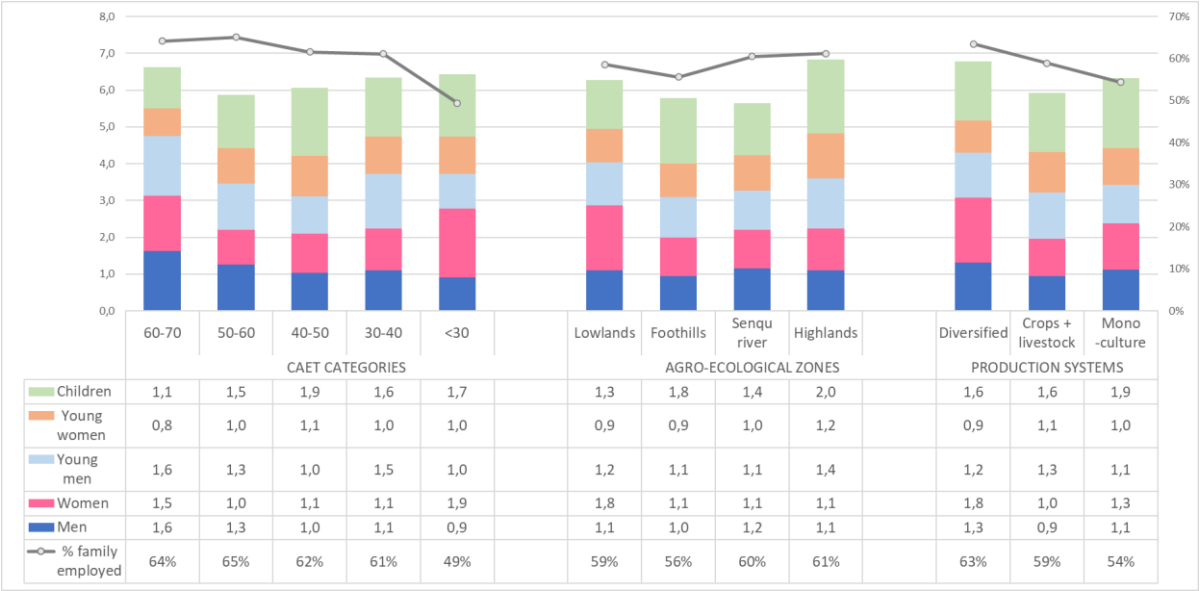
	60-70	50-60	40-50	30-40	<30	Lowlands	Foothills	Senqu river	Highlands	Diversified	Crops + livestock	Mono -culture
	CAET CATEGORIES					AGRO-ECOLOGICAL ZONES				PRODUCTION SYSTEMS		
Natural vegetation	0,0	0,1	0,1	0,1	0,0	0,2	0,0	0,1	0,0	0,1	0,0	0,2
Pasturelands	0,4	0,1	0,1	0,0	0,0	0,1	0,0	0,0	0,1	0,1	0,0	0,2
Farming	4,2	4,1	3,3	2,3	2,2	4,1	2,8	3,0	1,8	3,0	3,0	2,3

Figure 5: Average surface of land for farming, pasture, and natural vegetation per typology of agroecological transition (CAET), geographical locations and production systems.

Since the sample is composed for the great majority by smallholder farms, there is a link between agroecological transition and surface of farms in Lesotho: more advanced agroecological systems tend to have more land for production.

In Lowlands, farms are slightly bigger than average (4.4 ha), while in the highlands they are slightly smaller (1.9 ha), but they have higher availability of common land used as natural pastures (not shown in the graph). Types of farms based on monoculture are on average smaller than the other types (2.6 ha vs 3.2 ha of the diversified systems).

2.2.2 Gender and age composition



	60-70	50-60	40-50	30-40	<30	Lowlands	Foothills	Senqu river	Highlands	Diversified	Crops + livestock	Mono -culture
	CAET CATEGORIES					AGRO-ECOLOGICAL ZONES				PRODUCTION SYSTEMS		
Children	1,1	1,5	1,9	1,6	1,7	1,3	1,8	1,4	2,0	1,6	1,6	1,9
Young women	0,8	1,0	1,1	1,0	1,0	0,9	0,9	1,0	1,2	0,9	1,1	1,0
Young men	1,6	1,3	1,0	1,5	1,0	1,2	1,1	1,1	1,4	1,2	1,3	1,1
Women	1,5	1,0	1,1	1,1	1,9	1,8	1,1	1,1	1,1	1,8	1,0	1,3
Men	1,6	1,3	1,0	1,1	0,9	1,1	1,0	1,2	1,1	1,3	0,9	1,1
% family employed	64%	65%	62%	61%	49%	59%	56%	60%	61%	63%	59%	54%

Figure 6: Average age and gender composition of farms per typology of agroecological transition (CAET), geographical locations and production systems.

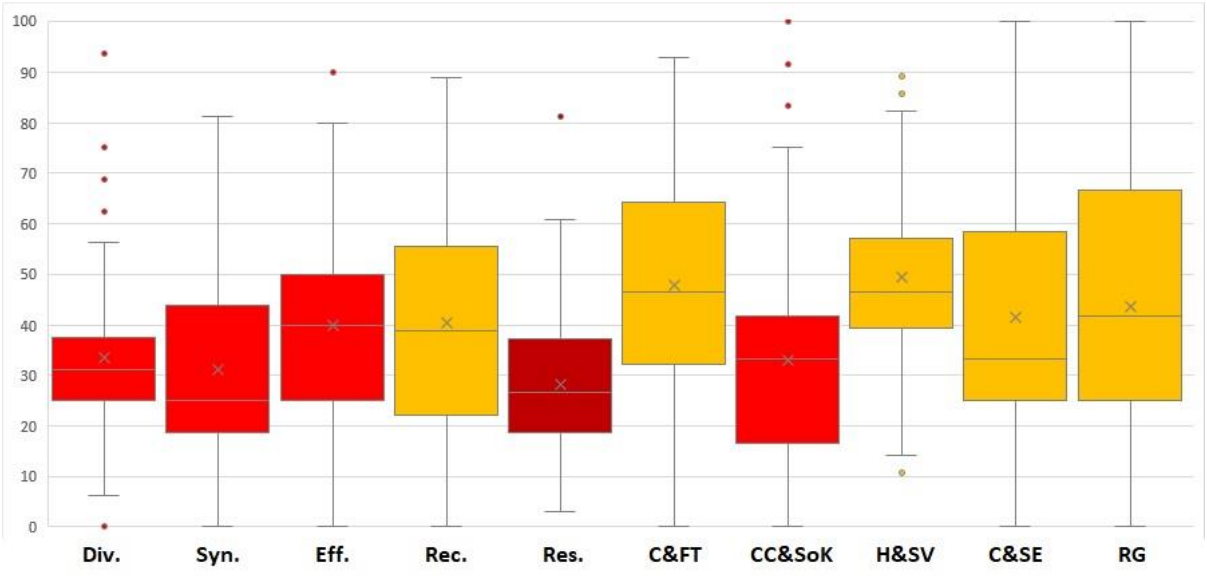
In the assessed farms, there are on average more women than men, but men form a slightly higher percentage of the agricultural workforce. The is a similar gender and age composition through the different types of systems, even if systems more advance in the agroecological transition tend to employ a higher percentage of family members in the agropastoral production. The same can be said for diversified systems in comparison with systems in monoculture.

Image 5: Smallholder horticulture production in Lesotho.

3. Characterization of the Agroecological Transition (CAET) in Lesotho

TAPE's Step 1 (FAO, 2019), the **Characterization of the Agroecological Transition (CAET),** uses the 10 elements of agroecology (FAO, 2018) to assess the level of transition of the production systems evaluated: the 10 elements are disaggregated into 36 indices[4] with descriptive scales with 5 level of transition (scores from 0 to 4). The final scores are then converted into a percentage of transition for each element. The CAET aggregated score (the level of agroecological transition) is the average score across all the 10 elements.

The use of CAET in Lesotho reveals that the level of transition towards agroecology is quite limited, and that a large number of farms could not be considered agroecological (average CAET result of the sample is 39 percent), with 4 out of the 10 elements scoring below 40 percent, and none of them above 50 percent.



#	Diversity	Synergies	Efficiency	Recycling	Resilience	Culture & food traditions	Co-creation & sharing of knowledge	Human & social values	Circular & Solidarity Economy	Responsible Governance	CAET
Mean	33	31	40	41	28	48	33	49	42	44	39
Median	31	25	40	39	27	46	33	46	33	42	39
Max	94	81	90	89	81	93	100	89	100	100	72
Min	0	0	0	0	3	0	0	11	0	0	11
σ	15	17	20	21	14	21	20	16	26	23	11

Figure 7: Characterization of the Agroecological Transition (CAET) for the whole sample of surveyed farms in Lesotho.

3.1 Elements characterizing the agroecological practices implemented in the field

The poor results achieved in the elements of Diversity, Synergies, Efficiency, and Recycling shows how low is the actual implementation of agroecological practices in the field of surveyed farms. Results on **Diversity** (33 percent) indicate that the average farm in Lesotho is not very diversified in terms of crops, livestock, and natural vegetation, but also in terms of income-generating activities.

[4] A complete list of the 36 indices and their scores is available in the annexes.

The selected landscapes for this study are mostly located in the remote areas, where farmers grow mainly cereals, sometimes in monoculture. Horticultural production is very limited due to short periods free of frost (in some landscapes it is only 28 days per year).

Moreover, the functional diversity represented by **Synergies** is also very low (31 percent), implying little or no integrative management of the different components of the agroecosystem to generate positive ecosystem services. For example, producers in the mountains and the Senqu River Valley do not use any fertilizers, but their animals spend most of their times in the highlands, so the producers cannot collect manure to use for soil fertilization. Positive interactions between crops and soil (e.g. intercropping, crop rotations, etc.) are also very limited, as well as the overall biodiversity and natural vegetation on farm and around the farming area.

The element of **Efficiency** has a slightly higher score (40 percent) due to the fact that most of the farms self-produce the inputs for their agricultural production and do not depend on the use chemical fertilizers and pesticides, but still their overall productivity is low, and the household's needs are usually not met from agricultural production only.

The results for the element of **Recycling** are slightly better (41 percent), since farmers reuse as much as byproducts as that they can. For example, some livestock producers spread animal manure in the field before ploughing to fertilize soil. Moreover, the compacted animal manure from the kraal is dug, dried and used for cooking and heating up the houses. Most farmers are able to reproduce their own seeds (especially cereals), but production and use of renewable energy is very limited. Water saving is not common because there is plenty of clean water in the selected landscapes, especially in the highlands.

Image 6: Local farmers with sorghum production.

3.2 Element of resilience

Resilience is an emerging property of agroecological systems. The average score for this element was 28 percent, the lowest scores between all the 10 elements. This can be seen in relation with the high levels of poverty among farmers in Lesotho. Average producers in Lesotho, regardless of the zones they come from, lack stability in income and agricultural production, and are prone to natural or economic shocks and stresses, from which they have a very limited capacity to recover. Environmental resilience and capacity to adapt to climate change is also very low, especially due to the lack of diversification and to soil erosion in mountain landscapes.

Anything that negatively affects the wool and mohair industry seriously impacts on producers in the country, especially those in the highlands and Senqu River Valley, whose livelihoods depend on sheep and goats. For example, a recent change in the wool and mohair trade policy forced producers to sell their produce through one trader only, which resulted in decreased income and earnings.

In the same way, any natural shocks in all the regions can leave local producers stranded. Generally, farmers in the selected landscapes have small-scale farms with limited marketing opportunities except for wool and mohair, hence no savings that could help farmers during difficult times. Furthermore, their farms are not insured against any disaster that could hit them and the support from the government and from the local community is very limited. Due to remoteness of the landscapes, the farmers hardly ever access government subsidy and/or services.

3.3 Elements characterizing the social aspects of agroecology

Despite widespread food insecurity in rural areas of the country, **Culture and food traditions** has performed relatively better (49 percent) if compared to the other elements but still with low results. This suggests that a good number of farmers interviewed are aware of appropriate diet and nutrition practices, feel their traditional identity in terms of food consumption, and tend to use local varieties and breeds and to maintain traditional knowledge for food preparation. However, some of them suffer from food scarcity at certain periods of the year, while dietary diversity is generally low.

Image 7: Local farmers with maize production.

People in Highlands, Senqu River Valley and some parts of the foothills still uphold local tradition identity and culture. They still use their own plant varieties, prepare Basotho dishes, wear traditional attire and perform rituals. These are diminishing in the lowlands especially the urban areas where westernization is quickly replacing Basotho culture and traditions.

Sorghum and cattle play a vital role in the culture of Basotho. Sorghum is used to brew local beer to appease the ancestors and in celebrations and burials. Cattle are used for

paying bride price (Lobola), herders, and in burials and celebrations. Indigenous vegetables form an important part of the daily Basotho diet in the selected landscapes.

The element of **Co-creation and sharing of knowledge** measures the actual knowledge (and access to it) in agroecology and traditional organic practices that support agroecological transition. The low score for this element (33 percent) indicates that farmers have little knowledge of agroecological practices and principles, and few or no networks exist for the horizontal creation and transfer of knowledge and good practices. Nonetheless, the existence of local farmer forums who assisted with the selection of interviewees was assessed during data collection.

In remote mountain areas, because of the lack of good infrastructures, it is not easy to promote information and knowledge sharing amongst farmers, or between them and local extensionists and researchers. Government extension offices working in these landscapes are short on staff and these affect extension service and sharing of knowledge.

Human and social values have scored relatively better than other elements (49 percent), but still with low averages: working conditions in agriculture are harsh due to low productivity and social inequalities between rural and urban areas. This pushes many rural dwellers, especially youth, to emigrate to the capital city Maseru or to South Africa in search of better living conditions.

In the selected landscapes, livestock production is crucial but still considered a male-only activity. Therefore, women have very limited space for income generating activities, less access to land and natural resources, and no products or services are specifically directed to them.

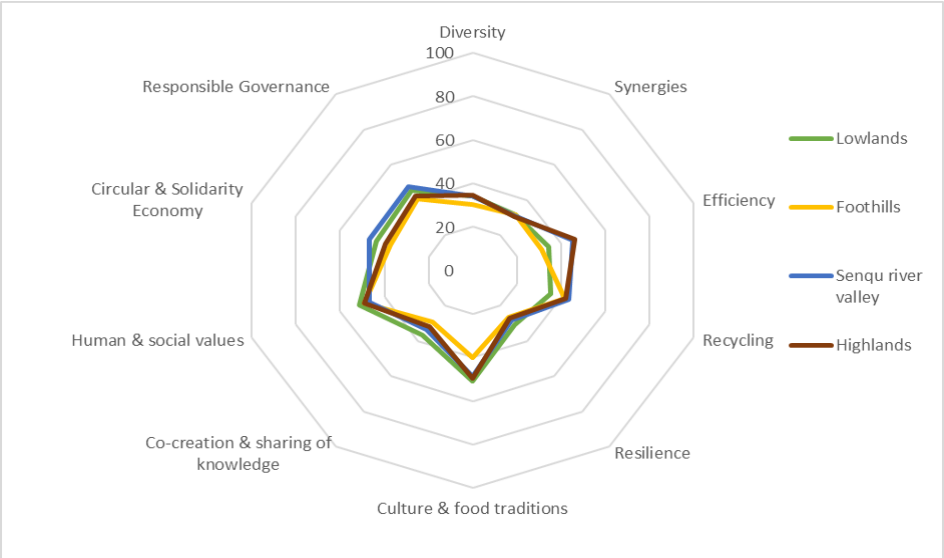
3.4 Elements characterizing the enabling environment for agroecology

With the partial exception of wool and mohair, local producers do not normally have well established marketing networks where they can sell their products and services locally and at a fair price. They do not have networks that can link them with consumers, they normally seek market individually and they do not share information on markets for fear of inviting competition. This is the case across all the zones, and this is the reason behind the low scores of the element of **Circular and solidarity economy** (42 percent).

The element of **Responsible governance** measures producers' empowerment, promotion of producers' organizations and associations and participation of producers in governance of land and natural resources. The low average scores for this element (44 percent) suggests that local farmers are not very empowered and that more could be done to involve them in the governance of local natural resources. However, since wool and mohair production is a priority to the country due to their contribution to GDP, producers in the mountains (where livestock rearing is more widespread) are comparatively more empowered than others in this sense, also because the government, in collaboration with development partners like FAO and IFAD, provides more support to wool and mohair industry.

The low scores for Responsible governance in most of the surveyed farms may indicate absence or inaccessibility or ignorance of laws, policies, and programs at the national level that can improve local agricultural production. Governmental policies and programmes of support are communicated to farmers by local extension services, whose effectiveness is normally very poor due to lack of staff and resources. This has direct effects on a number of elements such as Efficiency, Resilience, Circular and solidarity economy, Synergies, and finally to the overall agroecological transition of farms.

3.5 Characterization of the Agroecological Transition (CAET) in the 4 agro-ecological zones of Lesotho



Agro-ecological zones	# observations	Diversity	Synergies	Efficiency	Recycling	Resilience	Culture & food traditions	Co-creation & sharing of knowledge	Human & social values	Circular & Solidarity Economy	Responsible Governance	CAET
Lowlands	52	34	31	35	35	31	51	37	52	43	45	**39**
Foothills	40	30	32	31	42	27	40	29	49	37	41	**36**
Senqu river valley	40	34	31	45	43	28	49	34	47	47	47	**41**
Highlands	68	34	31	46	42	27	50	32	49	40	42	**39**

Figure 8: CAET results for the 4 agro-ecological zones of Lesotho.

CAET results disaggregated for the 4 agro-ecological zones of the country do not indicate relevant differences related to the geographic location: the average farms in Lesotho have not even begun their process of transition to agroecology, regardless of the different zones of the country. Nonetheless, farms in the Foothills seem to be on average the least advanced in agroecological terms, with the lowest levels in **Resilience**, **Culture & food traditions**, **Co-creation & sharing of knowledge**, and **Circular & solidarity economy**. These results should be confirmed in the analysis of performance in Step 2.

The most important difference across the different zones is found in the element of **Efficiency**, since the use of synthetic fertilizers and pesticides is almost absent in the Mountains and the Senqu River Valley, where the incidence of pests and diseases is relatively lower because of the cooler climate conditions. Less use of these external inputs means more self-sufficiency in agricultural production without harming the overall productivity (which, however, remains quite low everywhere) and hence a higher score in the element of Efficiency. This is also influenced by the higher self-sufficiency in terms of production of seeds, which is more common in the mountains zone than in the lowlands and foothills, where farmers use more hybrid seeds that cannot be reproduced and must be purchased year by year.

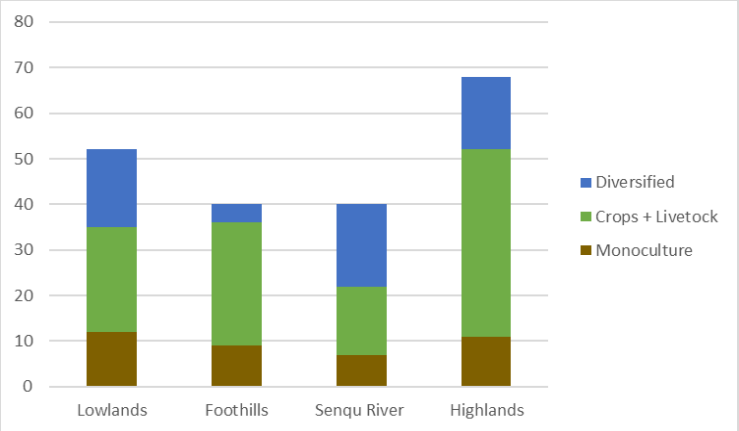


Figure 9: Number of observations and types of farms per agro-ecological zones.

Types of production systems are well balanced between the different agro-ecological zones: mixed crops-livestock farms are by far the most common production systems in Lesotho, representing more than half of the sample. Being the largest zone of the country, the Highlands have the highest number of farmers interviewed (34 percent) and the highest number of producers owning livestock, considering that sheep and goats play a major role in the lives of people in this area (cf. Figure 23).

3.6 Characterization of the Agroecological Transition (CAET) for the different types of production systems identified

Types of farms	# observations	Diversity	Synergies	Efficiency	Recycling	Resilience	Culture & food traditions	Co-creation & sharing of knowledge	Human & social values	Circular & Solidarity Economy	Responsible Governance	CAET
Monoculture	40	23	22	34	36	24	41	27	39	34	45	**32**
Crops + Livestock	105	32	29	41	40	28	46	32	49	37	36	**37**
Diversified (Crops + livestock + horticulture)	55	44	42	42	45	32	58	39	57	56	57	**47**

Figure 10: CAET results for the 3 types of production systems identified.

Although all the different types of production systems score below 50 percent and can therefore be considered "non-agroecological farms", important differences appear across their score in the 10 elements: the farms in **monoculture** are the least advanced in agroecological terms (CAET 32 percent), far less advanced than the **diversified** farms (mixed livestock, crops and horticulture) that have an average CAET score of 47 percent.

Apart from being more **diversified** (44 percent vs 23 percent), more **synergetic** (42 percent vs 22 percent), and more **resilient** (32 percent vs 24 percent) than farms in monoculture, diversified farms that grow different field crops and at the same time also raise livestock and have a plot for vegetable production can feed their animals on crops stover and leave the soil more covered, thus improving soil health and avoiding more efficiently soil erosion. The manure from livestock is then used in the field to fertilize the soil at planting, which helps the overall productivity (**Efficiency** 42 percent vs 34 percent) of the farm, which is also improved by vegetables, that form part of daily diet for Basotho, especially when eaten with soft porridge (Papa), which can also explain the much better results in the element of **Culture and food traditions** (58 percent vs 41 percent).

In terms of enabling environment, diversified farms are more linked with sustainable marketing practices (**Circular and solidarity economy** 56 percent vs 34 percent) and are more empowered and more organized in grassroots organizations (**Responsible governance** 57 percent vs 45 percent).

Mixed crops-livestock farms are the standard production systems in Lesotho and hence include a higher variety of results that are situated on average between the monoculture farms and the diversified ones.

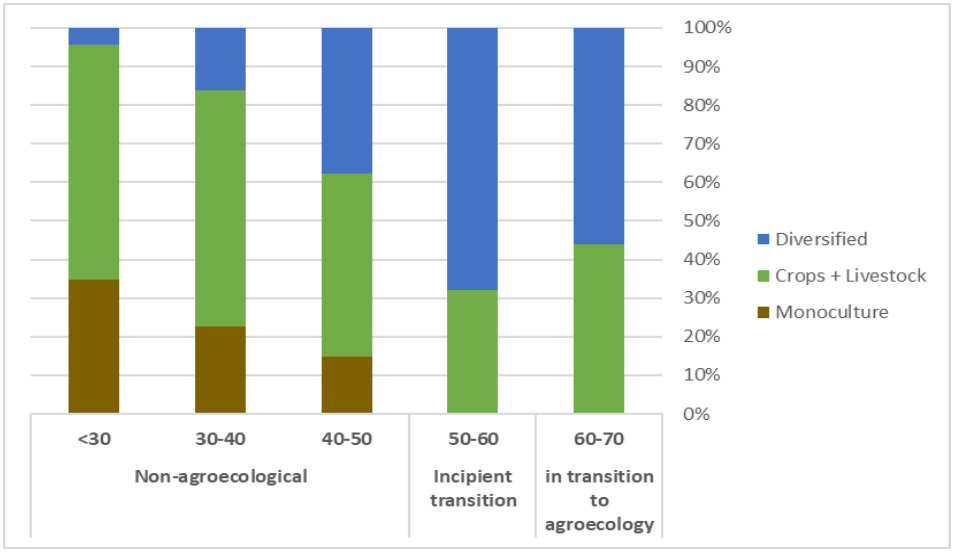


Figure 11: Relative composition of types of farms per category of agroecological transition.

The relative composition of the categories of CAET by types of farms can help to identify which type of production system is more prone to be agroecological in the target territories: Figure 11 indicates that all the most advanced agroecological farms raise livestock, while the most diversified production system identified in the area (crops + livestock + horticulture) tends to be less common in less advanced agroecological farms. On the contrary, the least advanced farms tend to have a higher percentage of monoculture. No farm of this type achieves higher levels of agroecological transition.

These important differences suggest that least diversified farms should be accompanied in a process of diversification of their production with an agroecological approach in order to advance in their process of transition and hence achieve higher levels of multidimensional sustainability.

3.7 Categories of agroecological transition

CAET categories		Diversity	Synergies	Efficiency	Recycling	Resilience	Culture & food traditions	Co-creation & sharing of knowledge	Human & social values	Circular & Solidarity Economy	Responsible Governance	CAET
In transition to agroecology	CAET 60-70	58	47	66	64	46	71	71	73	83	68	**65**
Incipient transition	CAET 50-60	43	45	52	55	36	67	45	65	64	62	**53**
Non-agroecological farms	CAET 40-50	36	35	43	47	31	56	41	52	53	52	**45**
	CAET 30-40	32	29	37	37	26	42	27	47	34	40	**35**
	CAET <30	22	18	30	25	20	30	18	37	17	23	**24**

Figure 12: CAET results per category of agroecological transition.

Figure 12 shows the results for the 10 elements for the 5 categories of CAET. This analysis can help identify which elements contribute the most to the advancement in the overall agroecological transition of farms.

For example, the element that has the biggest difference between the opposite categories is **Circular and solidarity economy**. This suggests that more advanced agroecological farms are strictly linked to the existence of local and territorial markets and short circuits of commercialization. The opposite is also true: sustainable marketing practices tend to support the overall agroecological transition of farms in Lesotho.

A similar reasoning can be applied to the element of **Co-creation & sharing of knowledge**, which measures the actual knowledge in agroecology: more advanced levels of transition to agroecology are inevitably connected to the crucial knowledge of agroecological practices and principles. In this sense, there is a lot of room for the project to help and support the horizontal spreading of this knowledge.

As a result of more widespread knowledge in agroecology, results for the elements describing the sustainable practices implemented in the field (**Diversity**, **Efficiency**, and **Recycling**) are much higher for more advanced agroecological farms. The same goes with the elements characterizing the social dimension of agroecology (**Culture & food traditions** and **Human & social values**).

Concerning the element of **Resilience**, even if more advanced agroecological farms have higher scores, average results for this element are low everywhere. This is due to the structural issues at

national level described earlier. The same can be said for the element of **Synergies**: there is a lot of room for the project to improve the positive interactions between the different components of the agroecosystems (crops, livestock, soil, trees, natural vegetation, etc.) for all kinds of farms.

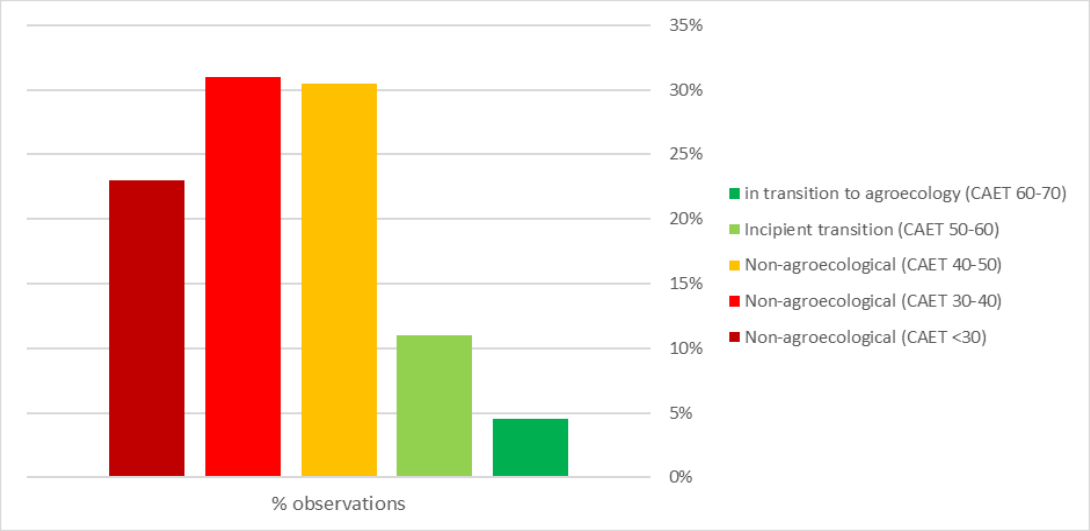


Figure 13: Number of observations per category of agroecological transition.

Figure 13 presents the relative composition of farms per categories of agroecological transition, as explained in the methodology section: the great majority of farms in the sample (84 percent) have an average CAET score below 50, so they can be considered "**non-agroecological farms**", 11 percent of the sample have a CAET score comprised between 50 and 60, and can thus be considered "**farms at an incipient level of transition**", while a little minority (4.5 percent) can be considered "**farms in transition to agroecology**", since they have a CAET score comprised between 60 and 70. Only one farm has achieved a CAET level above 70, but it has been included into the latter category.

4. Multidimensional performance of agroecology

TAPE's Step 2 collects quantitative data on the **core criteria of performance** considered essential for the multidimensional sustainability of productive systems in agriculture and strictly linked to the achievement of the SDGs (FAO, 2019).

By analyzing the links between the variables of TAPE's Step 1 and Step 2, we can assess the multi-dimensional performance of farms and the role of agroecology in achieving different dimensions of sustainability.

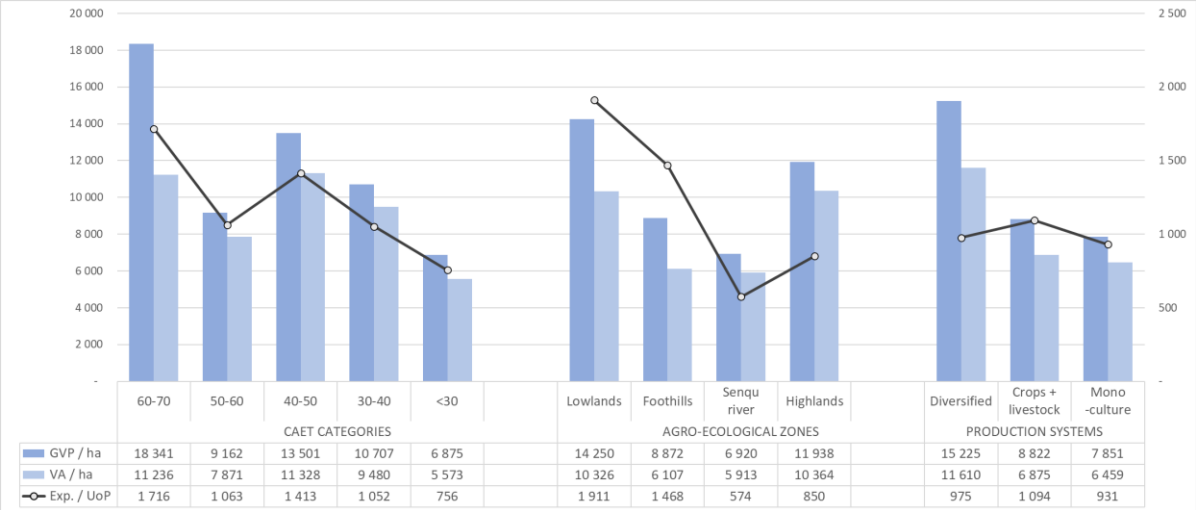
4.1 Economic dimension

Economic indicators	CAET	Diversity	Synergies	Efficiency	Recycling	Resilience	Culture & Food Traditions	Co-Creation & Sharing of Knowledge	Human & Social Values	Circular & Solidarity Economy	Responsible Governance
Gross value of the production / ha	**0,11**	0,17	0,06	-0,05	0,06	0,01	0,19	0,01	0,08	0,04	0,11
Value added / ha	**0,10**	0,16	0,06	-0,04	0,06	0,00	0,18	-0,01	0,08	0,03	0,11
Expenditures / UoP	**0,17**	0,10	0,05	-0,06	-0,04	0,18	0,18	0,25	0,18	0,10	0,13
Gross value of the production / pers	**0,11**	0,17	0,06	-0,05	0,06	0,01	0,19	0,01	0,08	0,04	0,11
Value added / pers	**0,09**	0,04	0,00	-0,09	0,05	0,03	0,14	0,19	0,15	0,07	-0,05
% people earning less than 1.90 USD / day	**-0,24**	-0,20	-0,12	-0,15	-0,01	-0,26	-0,33	-0,12	-0,08	-0,13	-0,09
Net revenue / pers	**0,06**	0,10	0,01	0,07	0,12	0,06	0,11	-0,05	0,04	-0,03	-0,04
Perception on the eveolution of revenues	**0,22**	0,13	0,16	0,10	0,01	0,49	0,26	0,08	0,07	0,04	0,13
Marketing orientation	**-0,04**	-0,02	-0,11	0,11	-0,03	0,11	-0,05	-0,07	-0,12	-0,07	0,00
% of revenue generate by animals	**-0,06**	0,17	0,09	-0,03	-0,01	-0,12	-0,09	-0,15	0,00	-0,09	-0,05

Table 1: Statistical correlations between the level of agroecological transition (CAET), the 10 Elements of Agroecology, and the economic indicators of performance.

Table 1 indicates that there are positive but weak correlations between the levels of agroecological transition and the economic performances of evaluated farms. The weak correlations (index ρ is generally lower than 0.25) is due to the fact that the sample is very unbalanced and mostly composed by non-agroecological systems (cf. Figure 13). The analysis of performance through the different typologies selected can help identify patterns that do not appear in the statistical correlation.

The confrontation of median[5] results of economic indicators shows that there is a positive link between agroecological transition of farms in Lesotho and their agricultural output in economic terms: more advanced agroecological farms have a higher **value of the agropastoral production (productivity) per hectare** and produce globally more wealth per hectare (**value added**) through their agricultural activity. Figure 14 also shows that higher levels of productivity per hectare are strictly linked to higher levels of **expenditures per unit of production**, which is higher in more advanced agroecological systems.



	60-70	50-60	40-50	30-40	<30	Lowlands	Foothills	Senqu river	Highlands	Diversified	Crops + livestock	Mono -culture
	CAET CATEGORIES					AGRO-ECOLOGICAL ZONES				PRODUCTION SYSTEMS		
GVP / ha	18 341	9 162	13 501	10 707	6 875	14 250	8 872	6 920	11 938	15 225	8 822	7 851
VA / ha	11 236	7 871	11 328	9 480	5 573	10 326	6 107	5 913	10 364	11 610	6 875	6 459
Exp. / UoP	1 716	1 063	1 413	1 052	756	1 911	1 468	574	850	975	1 094	931

Figure 14: Farms' gross value of the production (GVP) per hectare, value added (VA) per hectare, and expenditures per unit of production (in LSL) per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

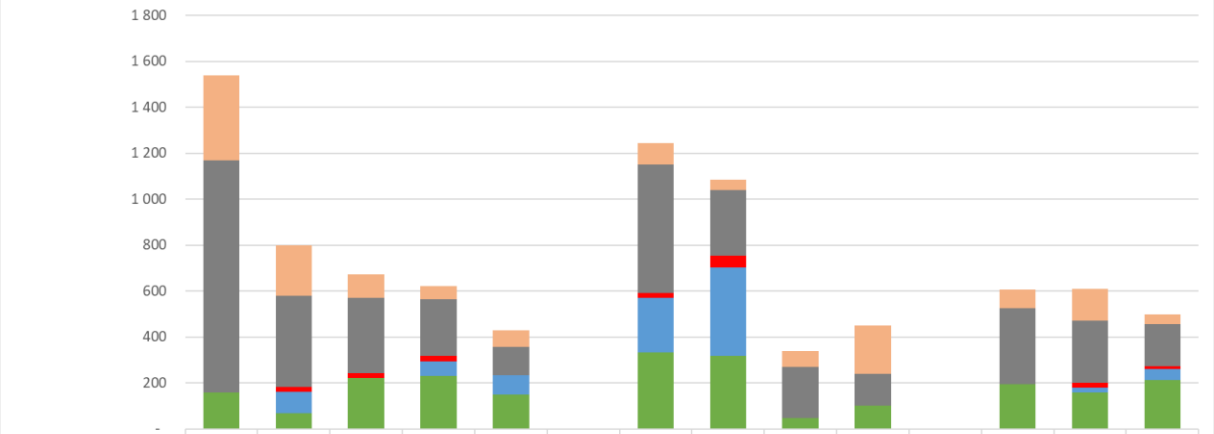
In the geographical typology, farms situated in the Lowlands have higher productivity and value added per hectare supported by higher expenditures per unit of production than those situated in the other zones. Despite having smaller surfaces of land (cf. Figure 5), farms in the Highlands have a more valuable production per hectare because they are more specialized in animal production and can exploit more areas of common pasturelands. The importance of sheep for the economic performance of production systems in Lesotho is underlined by the higher correlations with the element of **Culture and Food Traditions**, which measures, among others, the presence of traditional and well adapted varieties of crops and breeds of livestock. In this case, the presence of local sheep that produce a very good quality wool are linked to better economic performance of rural households.

In the typology of production systems, diversified farms that include the production of different kinds of crops, livestock and vegetables, are considerably more productive and create more wealth with relatively less expenditures per unit of production than the other two types of systems, and especially than those in monoculture.

[5] For economic data, the median of the results is considered, because it excludes the outliers and possible mistakes done during the data collection that would be included in the average results.

The higher productivity of more advanced agroecological farm is supported, among others, by higher **expenditures on inputs** (cf. Figure 15). For example, these farms spend more for livestock (feed and veterinary services) because they raise on average more animals. The higher expenditures in machineries and farming inputs (seeds and fertilizers) shows that in the context of poor and smallholder farmers in Lesotho, the rare farms that are more advanced in their agroecological transition (cf. Figure 11) tend to coincide with the most productive, resilient and least poor. Nonetheless, this dependence on external inputs also explains why these farms cannot be considered "fully agroecological". By advancing in their process of transition, these systems are expected to lower their dependance on external inputs which should be substituted with internally produced or recycled inputs and with ecosystem services provided by the agroecosystem (cf. Figure 12: low levels in the element of **Synergies** even for the most advanced agroecological farms).

Nonetheless, it is important to note that the most advanced agroecological type virtually uses no agrochemicals (fertilizers and pesticides), while all the other types do. The project should focus on the creation of appropriate knowledge and technology to enable these farmers to self-produce the inputs that they are currently purchasing (e.g. production of organic fertilizers, biogas, and pesticides through manure; strategies for the ecological management of pests; etc.) with little returns on the overall productivity, especially in the Foothills zone.



	60-70	50-60	40-50	30-40	<30	Lowlands	Foothills	Senqu river	Highlands	Diversified	Crops + livestock	Mono-culture
	CAET CATEGORIES					AGRO-ECOLOGICAL ZONES				PRODUCTION SYSTEMS		
Exp LS / LSU	372	220	100	55	71	91	45	70	210	81	140	42
Machineries / ha	1 010	395	330	246	122	560	286	223	139	330	268	185
Pesticides / ha	-	23	19	26	-	22	51	-	-	-	21	12
Fertilizers / ha	-	93	-	64	87	239	384	-	-	-	21	46
Seeds / ha	158	67	222	230	148	332	318	47	101	195	160	213

Figure 15: Composition of farms' expenditures (in LSL): expenditures on i) livestock per LSU, ii) machineries per hectare, iii) pesticides per hectare, iv) fertilizers pe hectare, and v) seeds per hectare per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

Figure 15 shows that levels of expenditures per unit of production are very different when disaggregated by agro-ecological zones: in Lowlands, expenditures for farming inputs and mechanization are considerably higher, while the Foothills also have high expenditures with less returns on productivity than the Lowlands (cf. Figure 14). Farms in Senqu River and in the Highlands spend much less for external inputs and virtually nothing for agrochemicals, probably because they cannot access them economically or physically, and not because they do not want to use them. In the Highlands, higher expenditures for livestock are due to the higher specialization on animal production.

The results of **gross value of the production** and **value added** show similar trends when they are normalized **per person** (family plus external workers): more advanced agroecological farms tend to have higher productivity and higher wealth created per person working in the system (Figure 16), and these results are strictly linked to the **percentage of people earning less than 1.90 USD per day from the agropastoral activity**, which is a good proxy indicator for measuring poverty in rural area (World Bank, 2015): there is a good negative correlation between this indicator and the overall agroecological transition (ρ = -0.24), which indicates that more advanced agroecological farm tend to host less poor people in agriculture.

	60-70	50-60	40-50	30-40	<30	Lowlands	Foothills	Senqu river	Highlands	Diversified	Crops + livestock	Mono -culture
	CAET CATEGORIES					AGRO-ECOLOGICAL ZONES				PRODUCTION SYSTEMS		
GVP / pers	13 305	12 799	12 515	7 910	5 589	15 500	9 150	11 586	7100	14 382	8 643	5 839
VA / pers	10 195	11 522	8 648	6 149	4 602	11 319	6 751	7 751	6 497	12 120	6 925	4 829
% <1,90 USD / day	67	73	72	82	98	79	85	80	81	75	84	83

Figure 16: Farms' gross value of the production (GVP) per person, value added (VA) per person (in LSL), and percentage of people earning less than 1.90 USD per day from the agropastoral activities per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

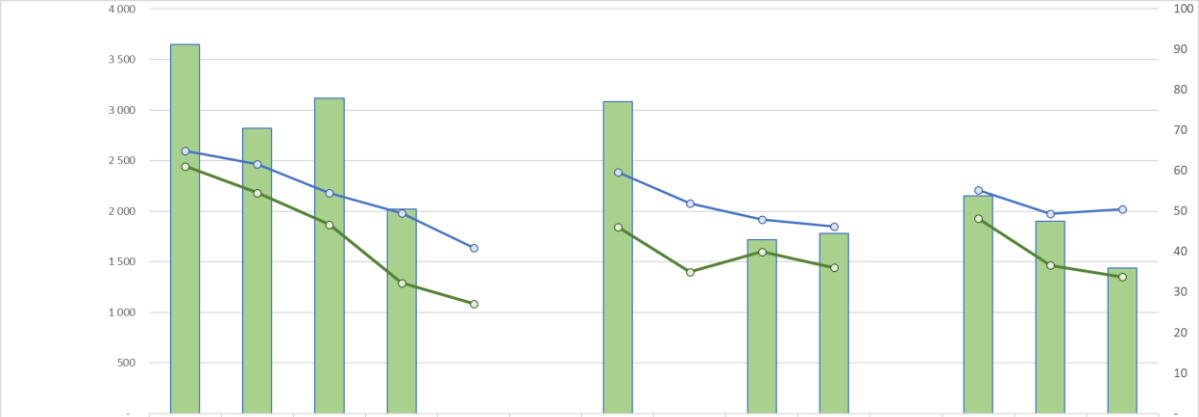
In the geographical typology, farms in the Lowlands have much higher productivity and value added per person due to the higher levels of mechanization, but the average levels of poverty are virtually the same as in the other zones. The Foothills zone are confirmed to be the one with the highest levels of poverty in agriculture.

In the typology of production systems, more diversified farms enjoy considerable higher levels of productivity and value added per person than the other types and have lower levels of poverty.

Despite having more expenditures per unit of production (cf. Figure 15), Figure 17 indicates that more advanced agroecological farms have higher **net revenues**. These could be even higher if they were more advanced in their transition to agroecology and could substitute, diminish, or avoid the use of external inputs (with e.g., higher scores in the elements of **Diversity, Synergies, Recycling** and **Efficiency**, cf. Figure 12).

The better results in the generation of revenues from agropastoral production are confirmed by the indicator that measures the **perception of the evolution of the revenues**:[6] there is a good correlation (ρ = 0.22) between agroecological transition and how producers perceive that their agricultural revenues are on an increasing trend, and even more with the single element of Resilience (ρ = 0.49).

Higher revenues are also strictly linked to more sustainable marketing practices (higher scores in the element of **Circular & solidarity economy**, cf. Figure 12) and to the overall **destination of agricultural production**.[7] In particular, more advanced agroecological farms are more market oriented than other categories, that tend to produce mostly for self-consumption, which also explains their lower revenues generated through agriculture.



	60-70	50-60	40-50	30-40	<30	Lowlands	Foothills	Senqu river	Highlands	Diversified	Crops + livestock	Mono -culture
	CAET CATEGORIES					AGRO-ECOLOGICAL ZONES				PRODUCTION SYSTEMS		
Net rev. / pers	3 650	2 822	3 117	2 019	-30	3 084	-15	1 721	1 782	2 150	1 899	1 438
Income perc	61	55	47	32	27	46	35	40	36	48	37	34
Destination agri prod	65	62	55	50	41	60	52	48	46	55	49	51

Figure 17: Results on net revenue per person from the agropastoral production (in LSL), main destination of the agricultural production (mostly market-oriented or mostly for self-consumption), and perception on the evolution of the income (if compared to how it was 3 years ago) per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

In the geographical analysis, once again, farms in the Lowlands are more performant and produce higher revenues. Farms in the Foothills have the lowest performance when analyzing revenues generated, because they spend considerably more on external inputs (cf. Figure 15), without having higher margins on the overall productivity (cf. Figure 14), and consequently, some of them have negative net revenues and the lowest perception of the evolution of their income (cf. Figure 17).

In the typology of production systems, diversified farms perform considerably better than the other types of farms, are more market-oriented and have a better perception of the evolution of their revenue.

[6] This indicator gives a score of 100 if the producers believe that their revenues have increased in the last 3 years, a score of 50 if they perceive that their revenues are the same, and a score of 0 if they perceive that their agricultural revenues are on a decreasing trend.

[7] This indicator gives a score of 100 if the farm is totally market oriented, a score of 50 if the agropastoral production is equally for marketing and self-consumption, and a score of 0 if the production is only for self-consumption.

All over Lesotho, livestock is a crucial component for income generation, draught power, and traditional ceremonies. The sources of the (gross) revenue indicate how important are animals for farms' agroecological transition and for their overall economic performance (cf. Figure 18). Similarly to the relative composition of types of farms (cf. Figure 11), these results suggest that there cannot be agroecological transition without strengthening local livestock production, which should be supported to be more productive and more sustainable. In particular, strategies well-adapted to local conditions should be studied in order to have fewer expenditures for the livestock component, so as to bring higher net revenues to the local producers.

Figure 18: Median composition of farms' gross revenues (in LSL) and average percentage of revenue derived from animal sources per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

The same results are confirmed when analyzing the types of farms: more diversified farms have a higher percentage of revenue derived from animals, and consequently higher overall revenues from agricultural production, since livestock can also be a driver of higher crop productivity.

In the geographical analysis, it is confirmed the importance of livestock for the generation of revenue in the Highlands.

4.2 Environment and health dimension

Environment and health indicators	CAET	Diversity	Synergies	Efficiency	Recycling	Resilience	Culture & Food Traditions	Co-Creation & Sharing of Knowledge	Human & Social Values	Circular & Solidarity Economy	Responsible Governance
Integrated management of pests	**-0,09**	-0,01	-0,15	0,38	-0,13	0,05	-0,01	-0,20	-0,21	-0,15	-0,05
Pesticides / ha	**0,17**	0,09	0,06	0,04	0,02	0,25	0,16	0,13	0,14	0,12	0,05
Soil health	**0,03**	0,03	0,12	0,19	-0,17	0,15	0,15	-0,04	-0,10	-0,13	0,06
Fertilizers / ha	**0,00**	0,11	0,10	-0,35	-0,07	0,00	0,02	0,00	0,13	0,08	0,04
Natural vegetation and pollinators	**-0,01**	0,00	-0,02	0,01	0,02	-0,06	-0,03	-0,15	0,02	0,07	0,04
Crops biodiversity	**0,44**	0,34	0,32	0,08	0,26	0,21	0,30	0,25	0,28	0,29	0,30
Animal biodiversity	**0,31**	0,47	0,29	0,13	0,21	0,16	0,23	0,06	0,11	0,12	0,13

Table 2: Statistical correlations between the level of agroecological transition (CAET), the 10 Elements of Agroecology, and the indicator of environmental and health performance.

Correlations between CAET levels and environmental and health indicators a slightly lower than the economic ones: if it is true that more advanced agroecological farms use fewer **chemical pesticides per hectare**, the levels of **integrated management of pests** are quite low for all the types (all below 60%), which also explains in part why the most advanced farms in the transition of this sample cannot be considered fully agroecological. On the other hand, the least advanced in the transition (CAET <30 percent) also make no use of pesticides, but the reason is that they cannot purchase them and not that they do not want to use them. Once again, this is an entry point for the project that should focus on creating knowledge among beneficiaries on how to implement locally adapted strategies for the ecological management of pests and diseases without using external and industrial inputs.

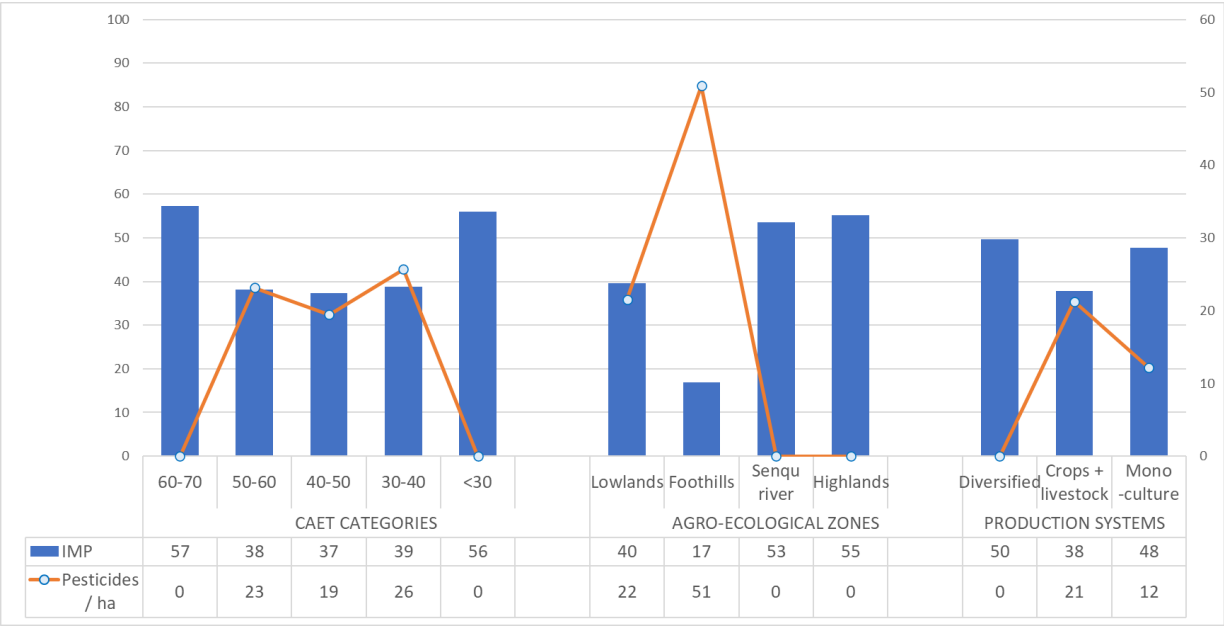


Figure 19: Integrated management of pests and expenditures on pesticides per hectare (in LSL) per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

Results of the geographical typology confirms that in the Lowlands and in the Foothills, farmers use much more pesticides than in the Highlands and Senqu River Valley, while the type of diversified farms virtually uses no pesticides at all, even with low levels of ecological management of pests.

Results on **soil health** shown in Figure 20 indicate similar trends: more advanced agroecological farms use less fertilizers per hectare and have slightly better soils, although the difference is not so remarkable (3.3 vs 2.9 on a maximum of 5). This is due to the fact that these farms are not fully agroecological and they have much room to implement more effective techniques and strategies for the management of their soil (cf. low scores in the element of **Synergies**).

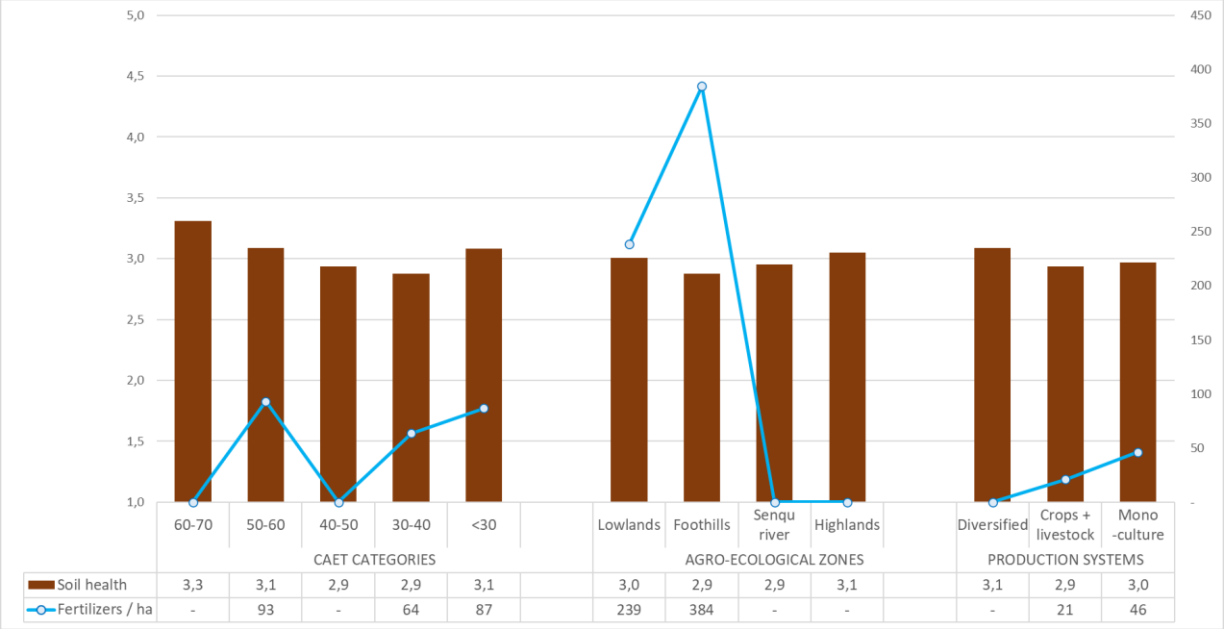
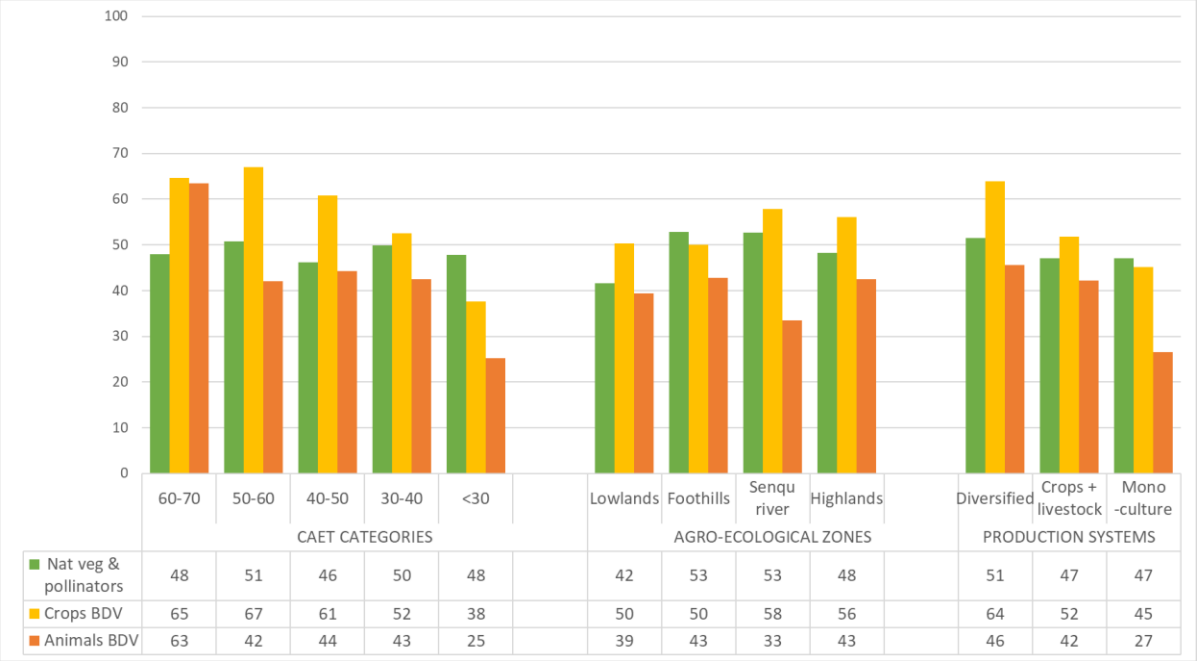


Figure 20: Soil health index and expenditures on fertilizers per hectare (in LSL) per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

There are no appreciable differences between the results on soil health for the different types of farms and for the different agro-ecological zones (all average results are comprised between 2.9 and 3.1). As it was for the pesticides, also for the fertilizers their use is much higher in the Lowlands and in the Foothills, while in the Senqu River Valley, in the Highlands and in diversified systems, the use of chemical fertilizers is virtually absent.

In terms of **agrobiodiversity**, there is a consistent link between agroecological transition and higher agricultural biodiversity on farms as shown in Figure 21. More advanced agroecological farms are more diversified in terms of crops (ρ = 0.44) and livestock (ρ = 0.31). However, differences in the scores of natural vegetation and pollinators on farms are not so pronounced, because average farms in the sample have not enough spatial diversity that favors ecosystem services and their surrounding environments are not well diversified, which is confirmed by the low scores in the element of **Synergies** (cf. Figure 7). This indicates that there is a lot of room for the project to support the enhancement of functional and ecological diversity within and around the target farms.



	60-70	50-60	40-50	30-40	<30	Lowlands	Foothills	Senqu river	Highlands	Diversified	Crops + livestock	Mono -culture
	CAET CATEGORIES					AGRO-ECOLOGICAL ZONES				PRODUCTION SYSTEMS		
Nat veg & pollinators	48	51	46	50	48	42	53	53	48	51	47	47
Crops BDV	65	67	61	52	38	50	50	58	56	64	52	45
Animals BDV	63	42	44	43	25	39	43	33	43	46	42	27

Figure 21: Presence of natural vegetation and pollinators, and crops and livestock biodiversity per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

Despite low levels of agrobiodiversity among all the different agro-ecological zones, farms in the Lowlands have lower levels of crops diversity and natural vegetation and pollinators on farm due to their higher specialization and major use of mechanization.

Finally, monoculture systems are much less diversified than other types of farms, especially in terms of lack of livestock in their agroecosystem and a highly uniform productive landscape.

In terms of livestock diversity, Figure 22 indicates that there is link between agroecological transition and presence of animals on farm: more advanced agroecological farms not only raise a higher number of sheep, but also of cows, goats, pigs, and chicken. An increased presence of animals is strictly related to a higher percentage of revenue generated by livestock products (cf. Figure 18), higher productivity (cf. Figure 14), and better revenues (cf. Figure 17).

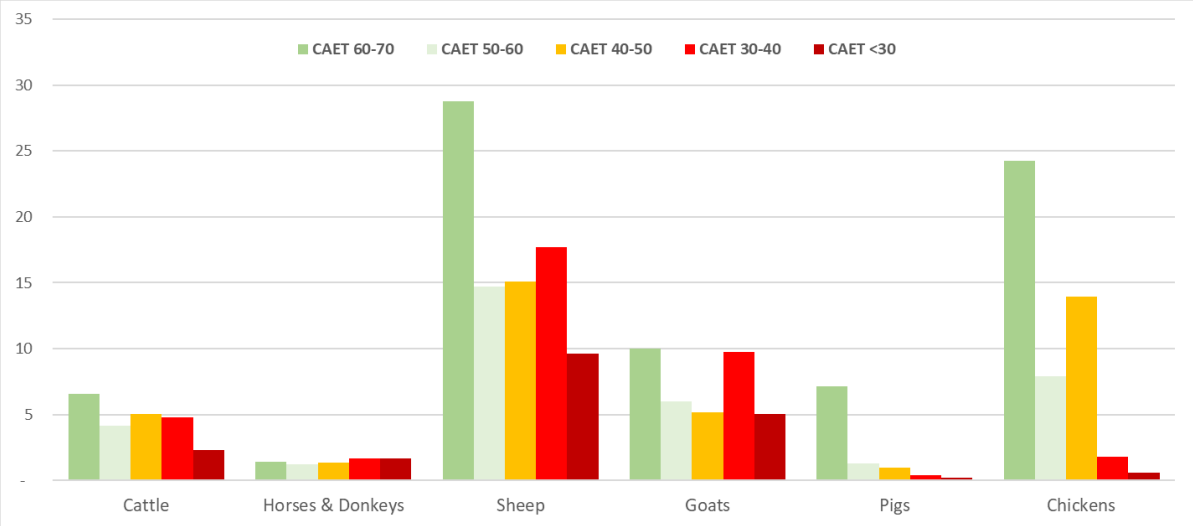


Figure 22: Average number of animals raised per categories of agroecological transition (CAET).

As indicated in Figure 23, in the Highlands there are on average more sheep and goats, but in the Lowlands there is a higher presence of pigs and chickens.

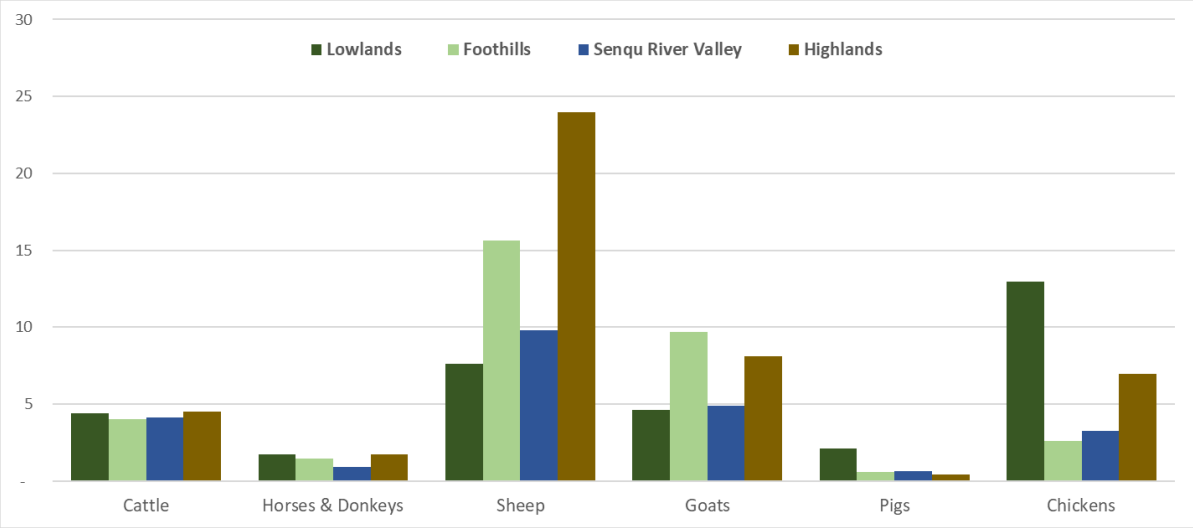


Figure 23: Average number of animals raised per geographical location of farms.

4.3 Social dimension

Social indicators	CAET	Diversity	Synergies	Efficiency	Recycling	Resilience	Culture & Food Traditions	Co-Creation & Sharing of Knowledge	Human & Social Values	Circular & Solidarity Economy	Responsible Governance
% of youth employed	**0,11**	0,11	0,07	0,00	0,03	-0,02	0,07	0,03	0,12	0,09	0,11
Opportunities for youth	**0,20**	0,18	0,27	0,01	0,04	0,27	0,16	0,05	0,09	0,10	0,10
Youth emigration	**0,06**	0,09	0,15	0,10	-0,05	0,16	0,18	-0,14	-0,01	-0,05	0,02
% of women employed	**-0,13**	-0,12	-0,14	-0,10	-0,01	-0,11	-0,10	0,02	-0,06	-0,08	-0,12
A-WEAI	**0,13**	0,20	0,02	0,12	0,11	0,10	0,04	0,01	0,05	0,11	0,02

Table 3: Statistical correlations between the level of agroecological transition (CAET), the 10 Elements of Agroecology, and the indicator of social performance.

As confirmed by the correlations on indicators of **youth empowerment** presented in Table 3, young people tend to have more employment opportunities in more advanced agroecological systems, but the emigration trends are high in all systems because youth is willing to emigrate to the capital city Maseru or to South Africa. This is especially true for households in the Senqu River Valley, while in the Highlands there is more employment of young people and less proneness to emigrate.

The diversified systems have the best performances in terms of employment opportunities for youth while at the same time having the lowest levels of proneness to migration.

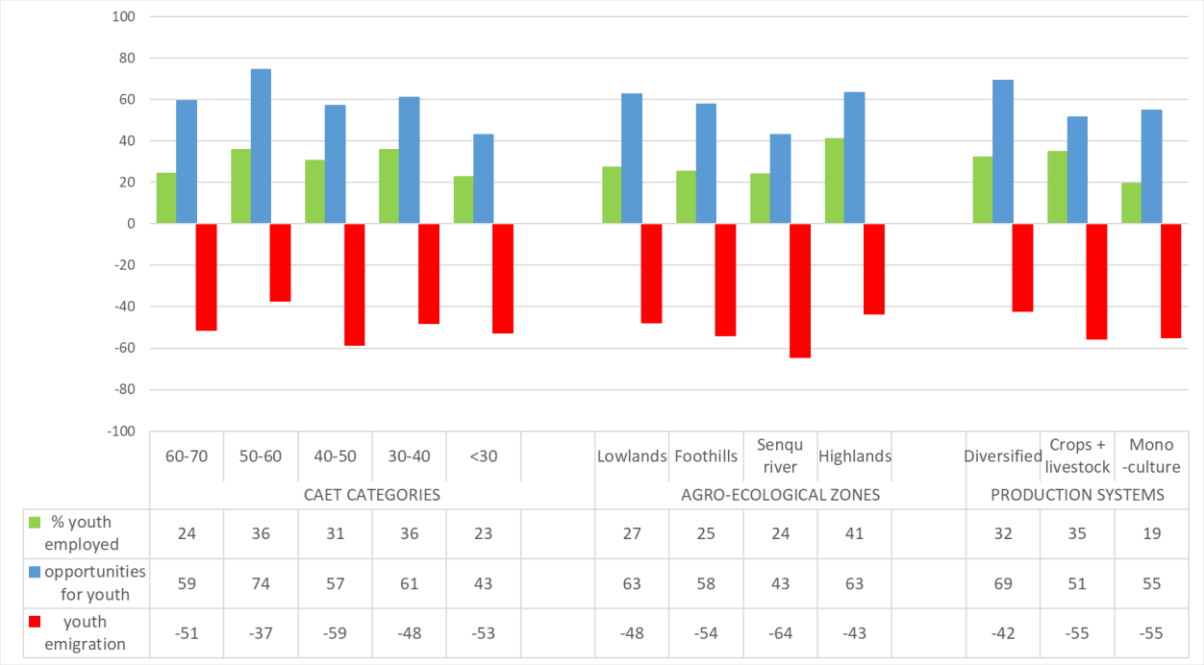


Figure 24: Youth employment score, proneness of young people to emigrate, and percentage of young people working on farm per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

Concerning **women's empowerment**, Figure 25 shows that results of the index based on the **A-WEAI** (FAO, 2019) are similar across the different types of farms. However, there is a decreasing trend between CAET levels and percentage of women employed on farm: in Lesotho, more advanced agroecological farms employ less women. This is an important point that should be addressed: there can be no complete process of transition to agroecology without the full involvement of women and the acknowledgement of their crucial role in agropastoral production.

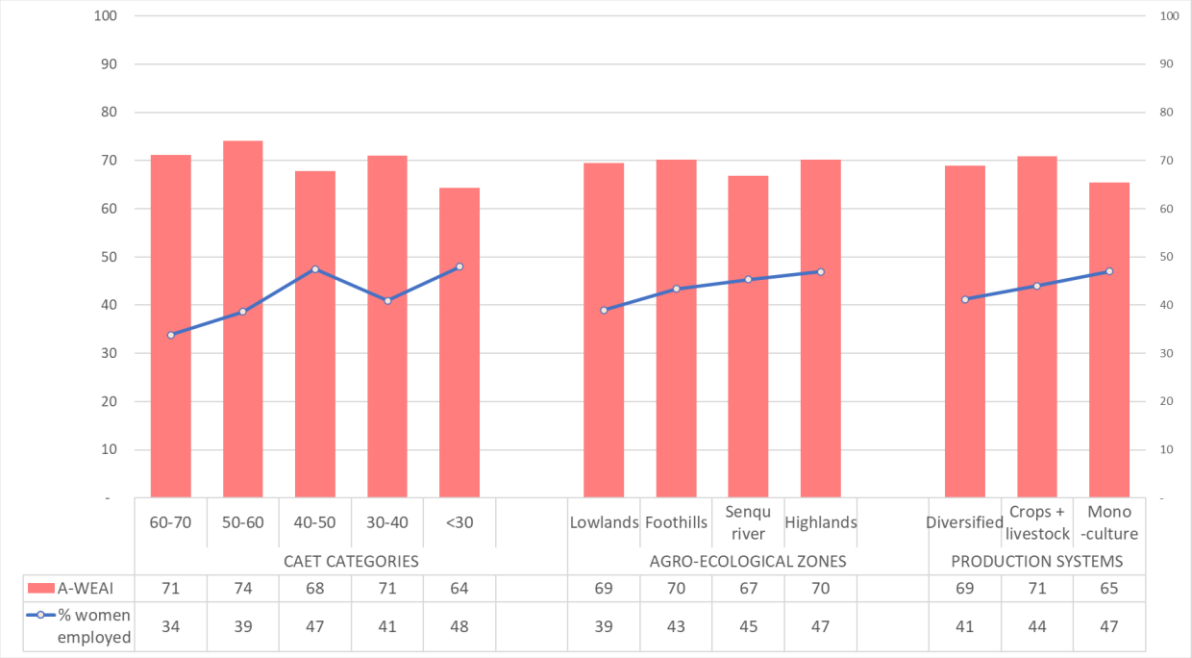


Figure 25: Women's empowerment (WEAI) and percentage of women working on farm per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

Even if employed in a lower number, the results suggest that women in more advanced agroecological farms are slightly more empowered, because they have more voice in the decision-making processes on crops and animal production, in the decision-making on how to use the income generated by agricultural activities. The low average scores in the indicator of leadership indicate that there is room for developing organizations specifically dedicated to women's empowerment.

Types of farms		Score on the 5 indicators of WEAI					WEAI
		Decision making production	Decision making income	Perception decision making	Time burden	Leadership	
CATEGORIES CAET	60-70	97%	100%	57%	54%	40%	**71%**
	50-60	94%	98%	59%	46%	56%	**72%**
	40-50	91%	93%	57%	54%	47%	**70%**
	30-40	85%	93%	54%	58%	58%	**70%**
	<30	86%	81%	55%	45%	58%	**64%**
AGRO-ECOLOGICAL ZONES	Lowlands	88%	89%	54%	56%	49%	**69%**
	Foothills	90%	92%	58%	52%	55%	**70%**
	Senqu river	90%	92%	61%	45%	48%	**67%**
	Highlands	87%	91%	53%	54%	57%	**70%**
TYPES OF FARMS	Diversified	91%	95%	56%	52%	45%	**69%**
	Crops+ livestock	88%	91%	55%	56%	57%	**71%**
	Monoculture	85%	86%	56%	45%	52%	**65%**

Table 4: Average score of the 5 indicators of women's empowerment in agriculture index (A-WEAI) per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

4.4 Nutrition dimension

Indicators of nutrition	CAET	Diversity	Synergies	Efficiency	Recycling	Resilience	Culture & Food Traditions	Co-Creation & Sharing of Knowledge	Human & Social Values	Circular & Solidarity Economy	Responsible Governance
Dietary diversity	**0,04**	0,11	0,06	-0,06	0,01	0,30	0,09	0,08	-0,04	-0,13	0,00
Food exp. / pers	**0,15**	0,09	0,05	0,04	0,23	0,21	-0,02	0,23	0,13	0,06	-0,07

Table 5: Statistical correlations between the level of agroecological transition (CAET), the 10 Elements of Agroecology, and the indicator of nutrition.

Statistical correlations between agroecological transition and indicators of nutrition are weak, because **dietary diversity** has a poor performance for all the CAET categories, which means that average farmers in Lesotho have a poor and not diversified diet (all below 40%, meaning less than 4 groups of food consumed on average). Farms in the Lowlands have a slightly better dietary diversity than those in the other zones and producers have access to more meat and dairy products (cf. Table 6). Dietary diversity is more correlated with the element of **Resilience** (ρ = 0.30), which suggest that the most resilient farms in the area are those that enjoy the most diversified diet by spending more for the purchase of food.

Figure 26: Households' dietary diversity and expenditures on food for self-consumption per capita (in LSL) per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

Results on **food expenditures per person** are not linear but seem to suggest that more advanced agroecological farm spend less for food for self-consumption because they are more self-sufficient in terms of food production.

Grains (especially maize and other cereals) are the staple food in the area but the least advanced agroecological farms (which mostly coincide with the poorest of the sample) tend to consume fewer quantities, which are in turn compensated by higher consumptions of pulses, which might therefore be perceived as a food for poorer people. It is important that the project help rescue the production, consumption, and perception of pulses and legumes, which are nutritious crops for humans and can enhance soil's fertility.

Types of farms		% of households that have consumed the different groups of food									
		Grains, white roots and tubers	Pulses	Nuts	Dairy products	Meat, poultry, fish	Eggs	Vegetables (dark green)	Vegetable (others)	Veg & fruits (dark yellow)	Fruits (others)
CATEGORIES CAET	60-70	100%	33%	22%	33%	44%	33%	44%	33%	33%	11%
	50-60	100%	32%	9%	41%	36%	18%	73%	32%	27%	14%
	40-50	87%	49%	15%	25%	41%	23%	80%	28%	23%	8%
	30-40	87%	60%	3%	19%	40%	21%	81%	34%	31%	13%
	<30	78%	59%	4%	35%	11%	26%	80%	30%	15%	2%
AGRO-ECOLOGICAL ZONES	Lowlands	90%	50%	15%	42%	56%	35%	77%	37%	31%	15%
	Foothills	95%	68%	3%	15%	25%	20%	78%	25%	25%	10%
	Senqu river	80%	45%	8%	20%	35%	28%	78%	35%	33%	5%
	Highlands	84%	49%	7%	28%	21%	13%	79%	28%	15%	6%
TYPES OF FARMS	Diversified	87%	47%	11%	27%	38%	22%	75%	27%	18%	13%
	Crops+ livestock	85%	52%	6%	27%	37%	21%	81%	32%	27%	9%
	Monoculture	92%	59%	13%	28%	18%	28%	74%	33%	28%	5%

Table 6: Average consumption of different kinds of food groups per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

4.5 Governance dimension

Indicators of governance	CAET	Diversity	Synergies	Efficiency	Recycling	Resilience	Culture & Food Traditions	Co-Creation & Sharing of Knowledge	Human & Social Values	Circular & Solidarity Economy	Responsible Governance
Secure land tenure (men)	**0,05**	0,03	0,06	-0,04	0,02	0,10	0,04	0,03	-0,02	-0,01	0,10
Secure land tenure (women)	**0,04**	0,08	0,10	0,04	-0,04	0,06	0,04	0,08	-0,12	-0,05	0,06

Table 7: Statistical correlations between the level of agroecological transition (CAET), the 10 Elements of Agroecology, and the indicators of governance.

Table 7 indicates that there is no significant relationship between agroecological transition and access to land. However, the gender-disaggregated results for **secure land tenure** indicate that women have everywhere a lower access to land (and other natural resources and hence activities generating income), and that actions to enhance secure access to land are needed.

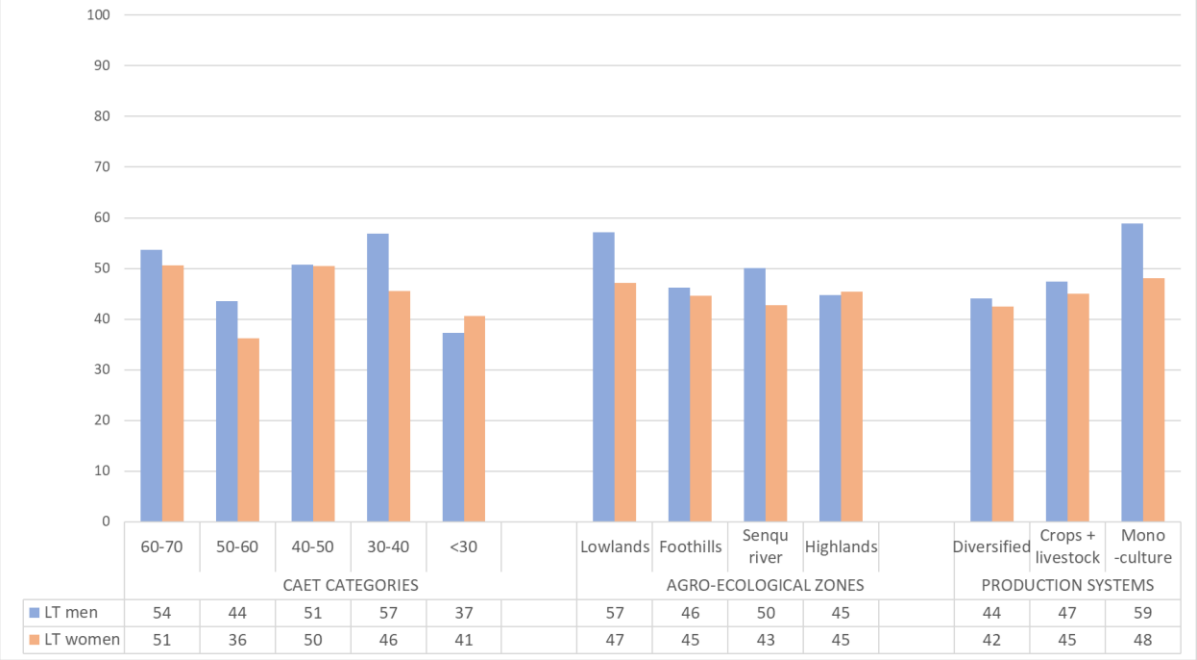


Figure 27: Score on secure land tenure for men and women per i) categories of agroecological transition (CAET), ii) agro-ecological zones of Lesotho, and iii) types of farms identified in the area.

Average levels of secure land tenure are slightly higher in the Lowlands compared with other zones for both men and women. The same can be said for farms in monoculturewhile farms in monoculture have

5. Conclusions

The use of TAPE in a selected territory can provide important data and key information about the overall sustainability of production systems in agriculture measured by different indicators of performance (FAO, 2019). It also provides insights on how the level of agroecological transition measured with the 10 Elements of Agroecology (FAO, 2018) links with the multidimensional performance. This information can be used to support projects and programmes of sustainable rural development and food systems.

Below is a summary of the results obtained with the use of TAPE in Lesotho:

- Average production systems in Lesotho have overall **low scores on the 10 elements of agroecology**. Most of these farms have not begun (or are not in the conditions to begin) their process of transition to agroecology and have low levels of sustainability with low productivity, harsh conditions of poverty and in a degrading environment.
- Disaggregated results per category of agroecological transition (CAET) indicate that **the great majority of farms in the sample (84 percent) can be considered non-agroecological**, while 11 percent can be considered "at an incipient transition", and only 4 percent are in an actual process of transition to agroecology. Only one full agroecological farm out of 200 has been found in the target territories.
- The implementation of agroecological practices and principles is very low, because most farmers in the sample are not aware of the possible strategies and activities that they might implement to improve their livelihoods and resilience, and they lack the resources for diversifying and enhancing their production. At the same time, the natural, social, and economic environment is not favorable for supporting agroecological transitions.
- Different regions of the country do not show significant differences in terms of agroecological transition, which remains low or very low everywhere.
- **Different types of farms show relevant differences** in terms of agroecological transition: diversified farms (that include crops, livestock and vegetables) have higher scores than farms in monoculture across all the 10 elements of agroecology, therefore indicating a higher multi-dimensional sustainability. **All the most advanced agroecological farms raise livestock**, while all farms in monoculture belong to the category of "non-agroecological farms".
- In terms of **practices implemented in the field**, more advanced agroecological farms all have higher levels of diversity of production (crops, animals, and economic activities), more implementation of practices for recycling of biomass and nutrients, and higher overall productivity.
- The element of **Synergies** is low even in the most advanced agroecological farms, indicating that there is much room for improving the functional diversity and the positive ecosystems services generated by the interactions of the different components of the agroecosystem (crops, livestock, trees, soil, natural vegetation, and pollinators).
- Even if more advanced agroecological farms are more resilient, the element of **Resilience is low or very low everywhere**, showing the economic, environmental, and social vulnerability of local producers. Moreover, Resilience is linked with dietary diversity and expenditures on food for self-consumption, which indicates that the most resilient households are those that have the ability to spend more for the purchase of food.
- More advanced agroecological systems are strictly linked to **more sustainable marketing practices**, **more decent work in agriculture**, and **more organized and empowered producers**.

These results are strictly connected to a much **more advanced knowledge** about sustainable practices and principles to be implemented within their agricultural production.

- There is a **clear link between agroecological transition of farms in Lesotho and their economic performance**: more advanced agroecological farms have higher (and/or more valuable) agricultural outputs and produce globally more wealth through their agricultural activity. Furthermore, the global value of their production per hectare is considerably higher, as well as the value of their production per worker.
- Despite having more expenditures for the purchase of external inputs, **more advanced agroecological farms generate more revenue from agricultural production**, they are more market oriented, have a more positive perception of the evolution of their income, and less people in poverty.
- The **animal component is essential for improved economic performance and for the overall sustainability and agroecological transition of farms**.
- Farms in the Lowlands tend to be better off, more productive, and more rentable than those in other zones.
- **Diversified farms** (mixed crops, livestock, and vegetables) **tend to be better off**, more productive, and more rentable than other types, especially compared to farms in monoculture.
- In the **environmental dimension of sustainability**, indicators are low everywhere, even if more advanced agroecological farms tend to have slightly better soils, to use fewer pesticides and fertilizers, and to have more biodiversity in terms of crops and livestock. The amount of natural vegetation and pollinators on farm is low everywhere.
- In the **social dimension of sustainability**, despite a lower percentage of women employed on farm, more advanced agroecological farms present more empowered women that participate more in the processes of decision-making.
- Secure land tenure is low among all the typologies and women tend to have worse levels of access to land than men.
- Average levels of youth empowerment are low or very low and their proneness to emigration is high, with slight differences among the different regions of the country. More diversified types of farms present more empowered youth less prone to emigrate.
- In terms of nutrition, dietary diversity is low among all the typologies, despite differences in the consumption of different groups of food. More advanced agroecological farms tend to have slightly better results in terms of diversified diet and food self-sufficiency.
- The results suggest that if there were fully advanced agroecological farms in the sample, the difference between the multi-dimensional performance would be even more pronounced.

6. Recommendations

ROLL's development objective is to ensure that rural communities adopt transformational practices for regenerated landscapes and sustainable livelihoods. Agroecology has been recognized as the most promising approach to contribute to transforming food systems by applying ecological principles to agriculture and ensuring a regenerative use of natural resources and ecosystem services, while also addressing the need for socially equitable food systems in which people can exercise choice over what they eat and how and where it is produced (HLPE, 2019). The results presented in this report confirm this statement.

Supporting the process of transition towards more agroecological systems of production within the target territories could be the key to achieve at least three of the four outcomes of the ROLL project, namely: (i) the change in resource use practices, (ii) the reduction of environmental degradation, and (iii) the improvement of livelihoods. Furthermore, ROLL's strategy emphasizes on finding effective and efficient means to achieve these outcomes in the long term, fostering a concerted effort of all the stakeholders involved. This report indicates that supporting agroecological transitions appear to be the most effective and efficient way for achieving these objectives.

If the project implements activities that are positively correlated to all the 10 elements of agroecology, the direct benefits will be multiple, encompassing economic, environmental, and social gains at household, community, and landscape levels. The project will improve livelihoods of the communities within the project area through improved and more sustainable use of local resources, enhanced income from on-farm activities, increased food availability and diversity, profitable income generating activities, the reduction of environmental degradation, and impact at social and organizational level of rural communities.

Using the 10 elements as framework to advance towards more sustainable food and agricultural systems in Lesotho, below is a summary of the recommended activities to support and implement:

Diversity – More diversified types of farms in Lesotho are linked to better economic, environmental, and social performances. The project should support target farms (and in particular those in monoculture) to diversify their production in terms of more crop species and varieties, possibly native, traditional, or well adapted to the local conditions, with a special focus on increasing the production of legumes, which can have positive spillovers on overall productivity of cereals, on soil fertility, and on human nutrition. Crop diversification should also include strategies to increase the production of vegetables, even in climates where normally the cold temperature would not allow it. Lesotho has a competitive geographical advantage as compared to neighboring South Africa in the production of vegetables, making the case for the development of sustainable horticulture under ROLL.

As shown in this study, the livestock component is crucial for improved economic performance and multi-dimensional sustainability. It is therefore key to increase the possibility to raise, reproduce, and profit from different species and breeds of locally adapted animals. In the meantime, it is important to ensure the sustainable production and reproduction of the animals already present in the target territories, with a special focus on sheep and goats for the production of wool and mohair, which can be extremely profitable for local producers.

The diversification of the economic activities within the farm is a crucial aspect for achieving higher levels of multi-dimensional sustainability.

Synergies, **Efficiency**, and **Recycling** – The results of this study indicate that the overall levels of synergies are very low even in the most advanced systems, which means that the functional diversity

among the different components of the agroecosystem is not well exploited. This leaves a lot of room for the project to stimulate the positive ecosystem services that can be generated through the interactions of crops, animals, soil, trees, pollinators, and natural vegetation.

Agroecological strategies to improve the environmental sustainability and the overall productivity of livestock production should be explored, both for intensive systems and for pastures on rangelands (e.g. rotational grazing systems).

The high levels of expenditures for productive inputs of the most advanced farms indicate that there is room for the project to lower the dependance on external inputs (seeds, feed, and fertilizers) that could be substituted with internally produced or recycled inputs and with ecosystem services provided by the agroecosystem. Least advanced producers have lower levels of dependance on external inputs simply because they cannot access them economically, not because they do not need them. The project should focus on the creation of appropriate knowledge and technology for beneficiaries to self-produce the inputs that they cannot purchase (e.g. production of organic fertilizers, biogas, and organic pesticides through manure; strategies for the ecological management of pests; technologies for the production and use of renewable energy; etc.). The possibility of self-reproducing seeds is also crucial in terms of sustainability.

In farming systems, the project should take a landscape approach to fight soil erosion, including agroecological techniques that combine the conservation of farms' soil (e.g. mulching, green manure, etc.) with the production of biomass (e.g. plantation of well adapted species and varieties of fodder or and legumes like pigeon peas on anti-erosion structures), with the multiple goal of enhancing soil health, increasing biodiversity, increasing the overall productivity of the land, and producing more crops for both humans and livestock.

This strategy should be implemented in parallel with the overall diversification of the landscape, in order to have more trees, shrubs, and natural vegetation that can stimulate synergies and produce positive ecosystem services. Strategies of reforestation and afforestation for exploiting the possibilities offered by agroforestry in sustainable crops and livestock production should be assessed.

Co-creation and sharing of knowledge is a crucial element for supporting agroecological transition: none of the practices and principles described above might be implemented if producers do not appropriate them. This means that beneficiaries must understand their issues and agree that the implementation of agroecological innovations will bring them actual benefits. At the same time, innovations and technologies should be appropriable and reproduceable with the use of local materials. This should happen as much as possible with a horizontal approach, meaning that farmers should learn from peers. Supporting Farmers Field Schools might be a good opportunity for spreading agroecological practices and principles.

The project should identify and rescue the already existing grassroot organizations and/or traditional authorities at community level and involve them in the process of co-creation and sharing of knowledge about agroecological transition. Producers' networks should be supported and linked with civil society organisations and governmental extension services.

The linkage between government extension officers and civil society organizations working in the selected landscapes is critical for future programming so that they can work together to strengthen horizontal creation and transfer of knowledge.

Culture and food traditions – The improvement of beneficiaries' agricultural productivity should primarily aim at the enhancement of their households' food security and nutrition. In the spirit of co-creation and sharing of knowledge, the project should form local communities in good nutritional

practices adapted to local crops (e.g. highlighting the importance of consuming a variety of pulses, vegetables, and fruits for a complete and diversified diet). Women and children should have a central role in improving households' nutrition.

Cereals are the staple food in the target territories, so the project should protect and fortify the sustainability of their production by rescuing local and well adapted varieties that might be planted in periods of food shortage (e.g. short-seasoned sorghum varieties). Nonetheless, the project should also focus its attention on the increase in production of well adapted and highly nutritive species and varieties of legumes that can complement the production of cereals, while at the same time having positive effects on soil fertility, and on human and animal nutrition. The data on the consumption of pulses seem to show that they are seen by locals as a food for poor people. The proposed trainings on good nutritional practices should also contribute to eliminate these kinds of stigma against foods that might be crucial to improve nutrition of beneficiaries' households.

Circular and solidarity economy – More advanced levels of agroecological transition and higher agricultural revenues are strictly linked to the existence of sustainable marketing practices. The project should support the organization of farmers' organizations and networks for commercialization, connect them with consumers, as well as support the creation of facilities and infrastructures for local and territorial markets, where producers can easily sell their production at fair prices.

Currently there is no formal branding for Lesotho milk and red meat products in the country. Investments and technical support are needed to diversify and boost mountain livestock production systems and improving the competitiveness of Lesotho mountain food systems and red meat and milk value chains.

Human and social values, **Responsible governance** – There is a need to empower beneficiary producers (with a special focus on women's role) from the point of view of the dignity of their work, considering the crucial role they play for food security of the whole country. Specific income-generating activities targeting women should be supported as well as their leadership at home and in the community. Moreover, there is also a need to empower rural producers and particularly women from an organisational point of view, so they can take significant decisions affecting their livelihoods, both individually and collectively, and lobby other institutions in favor of a supportive policy framework, make their voice hear at political level, and influence the governance of local natural resources. Women's organizations should be encouraged and supported.

Resilience – In the context of a natural environment that is deteriorating as a result of recurring droughts, heavy rains and recurrent crop diseases resulting in repetitive food crises, the project should support the implementations of agroecological innovations at field, social, marketing, and organizational levels. Through this holistic approach, the enhanced levels of transition to agroecology will result in improved resilience of rural communities. Resilience refers to both environmental shocks and marketing failures, since an increased diversity of production and availability of income will enhance the chances not to fall into vulnerability and to be the main actors of Lesotho's sustainable and resilient food and agricultural system.

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8. Annexes

10 Elements of Agroecology	CAET's indices
Diversity	Crops Animals (including aquaculture) Trees (and other perennials) Diversity of economic activities, products and services
Synergies	Crop-livestock-aquaculture integration Soil-plants management system Integration with trees (agroforestry, silvopastoralism, agrosilvopastoralism) Connectivity between elements of the agroecosystem and the landscape
Efficiency	Use of external inputs Management of fertility Management of pests & diseases Productivity and household's needs
Recycling	Recycling of biomass and nutrients Water saving Management of seeds and breeds Renewable energy (use & production)
Resilience	Stability of income/production and capacity to recover from perturbations Existence of social mechanisms to reduce vulnerability Environmental resilience and capacity to adapt to climate change Average Diversity
Culture & Food Traditions	Appropriate diet and nutrition awareness Local or traditional (peasant / indigenous) identity and awareness Use of local varieties/breeds and traditional (peasant & indigenous) knowledge for food preparation
Co-Creation & Sharing of Knowledge	Social mechanisms for the horizontal creation and transfer of knowledge and good practices Access to agroecological knowledge and interest of producers in agroecology Participation of producers in network and grassroot organizations
Human & Social Values	Women's empowerment Labour conditions Youth empowerment and emigration Animal welfare
Circular & Solidarity Economy	Products and services marketed locally (or with fair trade) Networks of empowered producers, presence of intermediaries and relationship with consumers Local food system
Responsible Governance	Producers' empowerment Producers' organizations and associations Participation of producers in governance of land and natural resources

Table 8: CAET's 36 indices used to assess the advancement of the 10 Elements of Agroecology.