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Fragility to Resilience in Central and West Asia and North Africa

WP2 - Genetic innovations, seed systems, and agrobiodiversity conservation

Farming systems surveys with farmers from the rural commune of Ait Ichou, Khemisset, Morocco

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Foreword

This report presents the findings of surveys conducted with farmers in the commune of Ait Ichou, Khemisset in the Middle Atlas of Morocco, focusing on their farming systems and cultivated crop agrobiodiversity. The study aimed to understand current agricultural practices, crop varieties used, and the level of agrobiodiversity within the commune. The information gathered in this report is crucial for several reasons.

First, it provides an assessment of the current agricultural practices and crop diversity at Ait Ichou. This knowledge is essential for developing informed strategies to support sustainable agriculture and biodiversity conservation in the region.

Second, the results can be used to identify potential challenges and opportunities faced by farmers at Ait Ichou commune. This information can then be used to design targeted interventions and support programs that address the specific needs of the local agricultural community.

Third, this report will serve as a valuable resource for researchers and decision-makers operating in Morocco's agriculture and biodiversity conservation field.

By understanding the unique farming systems and crop diversity of Ait Ichou commune, stakeholders can develop more effective strategies to promote sustainable agricultural practices and promote on-farm conservation of valuable agrobiodiversity throughout the country.

1. Background

Agrobiodiversity, the diversity of crop species and varieties, is a vital component of global biodiversity and plays a crucial role in ensuring food security and resilience in the face of climate change. Traditional agro-systems, where crop species have evolved and continue to evolve under a combination of human and environmental pressures, are the repositories of this invaluable diversity. These agro-systems are made by geographical, environmental, cultural, and socio-economic factors, collectively influencing crop diversity dynamics. Understanding these dynamics is essential for developing effective *in situ* on-farm conservation strategies that aim to maintain and enhance agrobiodiversity within these systems.

In situ conservation, which involves the maintenance of crop diversity within the agro-systems where they have evolved, has emerged as a promising approach to safeguard agrobiodiversity. This approach recognizes the importance of farmers' traditional knowledge and practices in managing and conserving crop diversity.

By conserving crops in their natural habitats and under the management of local communities, *in situ* conservation allows for the continued evolution and adaptation of crop species to changing environmental conditions and human needs.

To develop effective *in situ* conservation strategies, it is crucial first to understand the existing diversity within traditional agro-systems and the factors that shape this diversity. This requires a comprehensive description of the available crop diversity anchored in its geographical, environmental, cultural, and socio-economic context. Such a description can provide valuable insights into the processes that generate and maintain diversity and the challenges and opportunities for conservation.

The present study aims to contribute to this understanding by focusing on the traditional agro-systems of Ait Ichou commune in Morocco as a pilot site for on-farm conservation of local agrobiodiversity. Through surveys conducted with the farmers of Ait Ichou, the study seeks to document the diversity of crop species and varieties in the commune and the traditional knowledge and practices associated with their management and use.

The findings will contribute to the ongoing efforts to support sustainable agriculture and biodiversity conservation in the commune of Ait Ichou and beyond.

2. Methodology

2.1 Study areas

A prospection mission was the first step of this study to identify areas where farmers still cultivate landraces in agro-traditional systems. The final selection was made in consultation with representatives and technicians from the Khemisset Regional Directorate of Agriculture, supplemented by preliminary site visits and farmer interviews. The rural commune of Ait Ichou was chosen as the study area (Figure 1).

Ait Ichou commune is located in the Khemisset Province within Morocco's Rabat-Salé-Kénitra administrative region. At the time of the 2014 census, the commune had a total population of 1809 people living in 370 households.

The average altitude of the region varies between 1000 and 1400 m and benefits from an average rainfall of about 660 mm/year.

The region is dominated by cereals, combined with little arboriculture (olive, fig, and almond trees) and livestock (cattle, sheep, and goats). Traditional agriculture and marginal conditions characterize the surveyed area. Livestock production is the primary source of household income.

Figure 1: Map of the province of Khemisset showing the location of the rural commune of Ait Ichou (circled in yellow)

2.2 On-farm interviews

A total of 41 farmers, from 12 different villages and cultivating local landraces, were randomly selected for the survey. Table 1 illustrates the distribution of villages and farmers across Ait Ichou rural commune.

Table 1: Villages and number of farmers surveyed in Ait Ichou commune

Surveyed villages	Number of interviewed farmers
AIT HADDOU IMIZZINE	2
AIT HMAMA	3
AIT IKKEN	4
AIT M HAMED OUHADDOU	2
AIT MALOUK	6
AIT NACER	2
BIKNIMIR	1
CHORFA	6
IGHMEN	3
INJJAR	11
TILIOUINE	1
Total	**41**

The surveys, conducted in July 2023, took the form of informal discussions and interviews based on questionnaires developed to focus on the characterization of the farming systems and the local agrobiodiversity. The informal talks helped to deepen the organized surveys and to guide the fieldwork.

This study employed a semi-structured questionnaire to gather information on farmers and their farms. The questionnaire was designed to collect data in two main categories:

Farmer and farm details: The questionnaire gathered information on the farmers' personal and farm characteristics, including their age, level of education, number of resident and non-resident family members, cultivated area, number of plots on the farm, names, and relative

importance of all cultivated species, use of synthetic fertilizers or pesticides, and livestock details (species and feed resources).

Cultivated varieties: The questionnaire section focused on gathering information about the cultivated varieties. Farmers were asked to list the names of all cultivated varieties. For each variety, the questionnaire collected information on its status (traditional or modern), the area dedicated to its cultivation, the length of cultivation on the farm (recorded as the year of first cultivation), its description according to 33 morphological, agronomic, and post-harvest quality traits. The questionnaire also inquired about seed supply preferences, including the preferred source of seed (own production, purchase from relatives and friends, local market, or agricultural office), reasons for this preference, and details about seed selection practices, including whether selection is practiced, the stage of selection, individuals involved in the process, and the seed exchange network.

Photo 1: Surveys with farmers from Ait Ichou commune.

2.3 Data analysis

The study employed a mixed-methods approach, analyzing both quantitative and qualitative data collected from farmers.

The collected quantitative and qualitative data from the farmer surveys in Ait Ichou commune were organized into an Excel database. Using Microsoft Office Excel 2013, descriptive statistics such as means and frequencies were computed to summarize the data.

To assess the level of modernization among the farmers, a score ranging from 0 to 3 was calculated for each farmer, assigning one point for access to mechanization, use of synthetic fertilizers, and use of pesticides.

Multivariate analysis methods were employed to profile the different farms. Multiple Correspondence Analysis (MCA) was conducted using the FactoMineR package in R Software to reduce data dimensions and identify key variables. Subsequently, a Hierarchical Ascending Classification of Principal Components (HCPC) was performed using FactoMineR to classify farms into distinct groups. This analysis provided a typology of farms, revealing patterns in farming practices and levels of modernization within the community.

3. Results and discussions

3.1 Descriptions of farms and farmers in survey areas

The basic characteristics of farmers who participated in the survey are summarized in Table 2. The heads of the farms were mainly men (100% of the surveyed farmers are men), aged between 30 and 84 years.

On average, 27% of the farmers attended at least primary school, which varies considerably between the different villages. On the other hand, none of the farmers surveyed had attained higher education (Table 2).

Regarding family size, 17% of the respondents had a family of more than eight members, while family units with 3 to 5 members accounted for 32% of the respondents. About 27% of the households had a family size of between six and eight members, while 24% of all respondents had a family size of three or below.

The primary source of income for most respondents (94%) was the sale of agricultural products. However, only 6% of the respondents declared they have other sources besides agriculture.
The farmed area managed ranged between 1 hectare to 57 hectares with more than half of farms are less than 5 hectares. The majority of farmers were mixed farmers (96%) having both crops and livestock, while 4% were 'crops only' farmers.

Table 2: Demographic information of households in the study commune

Summary of farmers' demographic information		**Total (n= 41)**
Age (years)	Mean	58
	Minimum	30
	Maximum	84
Gender (%)	Male	100
	Femelle	0
Educational level (%)	Illiterate	73
	Elementary	5
	Primary school	7
	Secondary school	12
	High school	3
Family size (number per household)	> 3	24
	Between 3 and 5	32
	Between 6 and 8	27
	< 8	17
Sources of income (%)	Agriculture (crop and livestock)	94
	Agriculture + Other sources	6
Farm size (%)	Small < 5 ha	51
	Medium 5–10 ha	29
	Large > 10 ha	20
Farm type (%)	Crop only	4
	Livestock only	0
	Mixed	96

3.2 Description of agro-ecosystems in study areas

In this study, we first assessed agrobiodiversity at the species level. This level focused on the diversity of cultivated crops by conducting a comprehensive inventory of all plant species the farmers grow.

To assess crop diversity, we calculated a crop diversity index by dividing the average number of crop species planted by the average number of plots on the farm (Table 3).

Table 3: Number of plots, Number of crops, and Crop diversity index

Entity	Mean	Minimum	Maximum
Number of plots	3.41	1	9
Number of crops	3.07	1	9
Crop diversity	1.11	-	-

On average, each farmer manages approximately 3.41 plots, ranging from a single plot to as many as nine plots. This variation in plot numbers suggests differing scales of farming operations and the potential for diverse cropping strategies.

Similarly, the average number of crops grown per farmer was 3.07, with individual farmers cultivating between 1 and 9 crops. This indicates a general trend towards maintaining crop diversity, though some farmers might still practice monoculture.

The crop diversity index, averaging at 1.11, reflects the overall richness and evenness of crop distribution across these plots. Furthermore, we identified 15 different crop species across all villages. These crops were classified into three main categories: fruit trees (8), cereals (4) and pulses (3). The main crops grown are durum wheat, barley, oat, lentil, olive tree, and fig tree. (Figure 2).

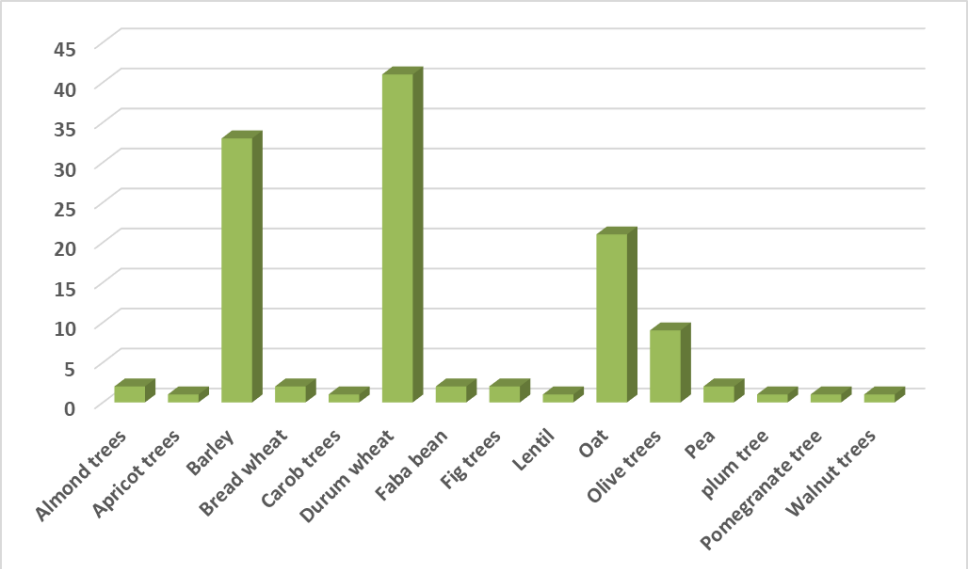

Figure 2: Crop species cultivated in the study areas

3.4 Livestock animals

Table 4 presents data on the number and distribution of livestock species and breeds within the surveyed area. The majority of farmers associated crops and livestock. Of the 41 farmers, only three did not have any livestock. Farmers reared 2.5 species on average (1 to 3), with no significant differences between villages.

The predominant species are local cow breed (Moroccan Blonde d'Oulmès-Zaër), local sheep breed (Moroccan Timahdite or "Bergui"), and local goat breed (the Atlas "Barcha").

Table 4: Number and breeds of livestock animals recorded in the surveyed area

Species/categories	Total number	Mean per farms	Min	Max	Races
Cattle					
Milk cows	122	3.05	0	20	*Oulmès*
Veal	42	1	0	10	*Oulmès*
Bulls	1	-	0	1	*Oulmès*
Sheep					
Adult ewe	923	23	0	160	*Timahdit*
Rams	168	4.2	0	50	*Timahdit*
Lambs	181	4.4	0	30	*Timahdit*
Goats	456	11	0	100	*Barcha*
Bee hives	20	0.49	0	14	-

3.5 Crop diversity and varietal richness

In the study, we also examined the diversity at the varietal level. This level explains the diversity and abundance of distinct varieties within each cultivated crop.

Table 5 lists the varieties of the main crops, particularly cereals and pulses, cited by the surveyed farmers. The table presents a comprehensive overview of crop diversity and varietal richness among interviewed farmers, highlighting traditional and modern varieties.

Durum wheat was represented by five varieties, with "Lbida" being the predominant traditional variety cited by all farmers (100%). In contrast, the modern varieties "Karim", "Marzak", "Carioca", and "Cocorit" had much lower citation rates, with "Carioca", and "Cocorit" being the most cited among them at 21.95%.

Bread wheat was less diverse, with only two modern varieties, "Marchouch" and "Achtar", cited by 4.87% and 2.43% of farmers, respectively.

Barley showed strong traditional varietal preference, with "Beldi" cited by 97.56% of farmers. Oat displayed a mix of traditional varieties, with "Lahmar" being significantly more cited (68.29%) compared to "Beldia" (7.31%).

The leguminous crops such as faba bean, lentil, and peas were represented dominantly by the traditional "Beldi" varieties but with lower citation percentages (24.39%, 14.63%, and 14.63%, respectively).

This data indicates a predominant dependence on traditional varieties for specific crops like durum wheat and barley, while modern varieties are less frequently cited, suggesting their limited adoption among farmers.

The preference for traditional varieties highlights the importance of these crops in maintaining agricultural biodiversity and cultural heritage within the community.

Table 5: Varieties of cereals and pulses cited by each surveyed farmer

Crop	Variety	Status	Number of Citation	Percentage of interviewed farmers having cited the variety
Durum wheat	Lbida	Traditional	41	100
	Karim	Modern	5	12.19
	Marzak	Modern	9	21.95
	Carioca	Modern	9	21.95
	Cocorit	Modern	1	2.43
Bread wheat	Marchouch	Modern	2	4.87
	Achtar	Modern	1	2.43
Barley	Beldi	Traditional	40	97.56
Oat	Lahmar	Traditional	28	68.29
	Beldi	Traditional	3	7.31
Faba bean	Beldi	Traditional	10	24.39
Lentil	Beldi	Traditional	6	14.63
Peas	Beldi	Traditional	6	14.63

3.6 Farmers' variety management

3.6.1 Seed source

Table 6 illustrates the sources of seed supply for the various crops. The primary source of seed supply for most crops studied was farm self-production. This is particularly evident for durum wheat, barley, and oats, where over 75% of farmers obtain seeds through self-production. This dependency on farm-saved seeds contributes significantly to the preservation of diverse landraces within these crops.

Local markets constituted a secondary source of supply, particularly for durum wheat and barley (21.95% each), while exchange with neighbors or relatives represented a less significant source overall. For bread wheat, faba bean, lentil, and peas, farmers prefer producing their seeds on farm and do not rely on external sources.

Table 6: Farmer's local seed sources

Crop	Self-production	Bought in the local market	Exchange with neighbors or relatives
Durum wheat	40 (97.56%)	9 (21.95%)	7 (17.07%)
Bread wheat	7 (17.07%)	1 (2.43%)	1 (2.43%)
Barley	37 (90.24%)	9 (21.95%)	4 (9.75%)
Oat	31 (75.6%)	6 (14.63%)	5 (12.19%)
Faba bean	7 (17.07%)	0 (0%)	0 (0%)
Lentil	5 (12.19%)	0 (0%)	0 (0%)
Peas	3 (7.31%)	0 (0%)	0 (0%)

Note: The table presents the number of citations for each seed source, with the percentage of citations within each category indicated in parentheses.

3.6.2 Selection

The practice and stages of varietal selection varied significantly among the crops studied (Table 7). Durum wheat exhibited selection practices on 100% of farms, while other crops, particularly legumes, displayed limited selection. For durum wheat, farmers declared practicing selection on spike (36%), followed by plant selection (31%). For bread wheat, despite the lower selection practice overall (21%), farmers prefer making selection on spikes (44%). For barley, selection was practiced on 92% of farms and was made on seeds after harvesting (68%). In contrast, selection for oats seed practiced on 75% of farms, relied on bulk sample selection (77%). Faba bean, lentil, and pea, with minimal selection practices (4%, 2%, and 2%, respectively), employed only bulk sampling as a selection stage.

These findings highlight diverse approaches to varietal selection, potentially influenced by crop-specific breeding systems and farmer preferences.

Table 7: Practice of selection and selection stage in Ait Ichou commune

Crop		Selection stage (%)			
	Percentage of farms where selection is practiced	Bulk sample from harvest	Special plot	Plant selection	Spike/ pod selection
Durum wheat	100%	21%	10%	31%	36%
Bread wheat	21%	22%	11%	22%	44%
Barley	92%	68%	5%	15%	10%
Oat	75%	77%	0%	12%	9%
Faba bean	4%	100%	0%	0%	0%
Lentil	2%	100%	0%	0%	0%
Pea	2%	100%	0%	0%	0%

3.7 Identification and characterization of different farmer profiles

A Multiple Correspondence Analysis (MCA) was performed to examine the relationships between various farming-related variables and the characteristics of farmers (Figure 3). The MCA plot illustrates the associations between categorical variables and identifies factors that distinguish different profiles within the farming community.

The MCA analysis revealed that the primary dimension (Dim 1) was correlated mainly by variables related to agricultural scale, such as the number of plots and crops. This dimension effectively distinguishes farmers who operate larger, more diverse farms.

In contrast, the secondary dimension (Dim 2) was influenced by socio-demographic factors, particularly education and female residency. This suggests that higher educational levels and female presence in farming households significantly have impacts on farming practices and decision-making.

The central positioning of variables like resident gender (male), cattle, equines, sheep, and sources of income suggests that these factors do not significantly differentiate farming profiles along the primary axes of variation captured by Dim 1 and Dim 2.

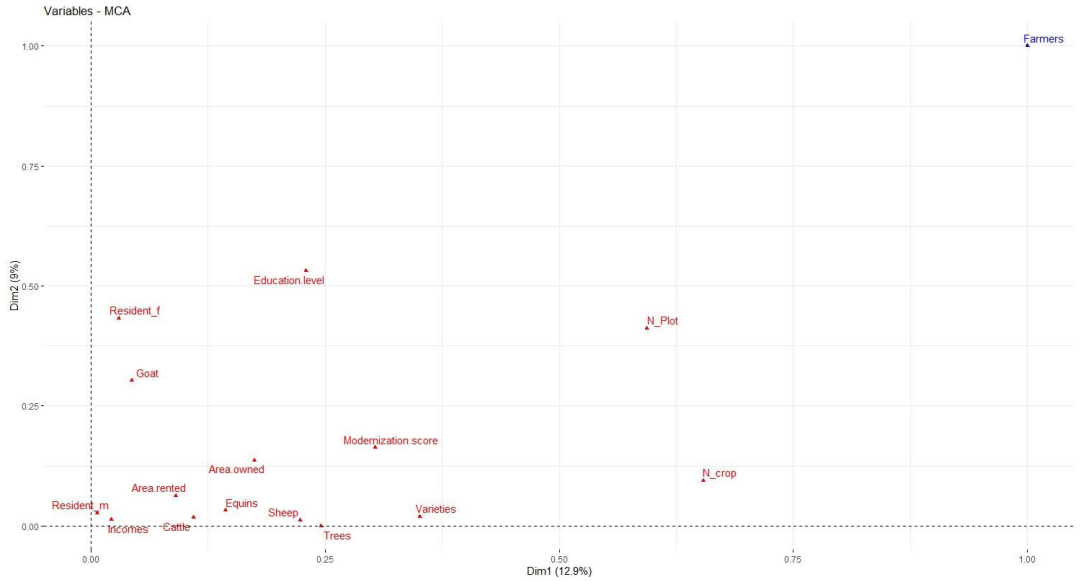

Figure 3: MCA plot illustrating relationships between farming-related variables (in red) and farmers (in blue). Dim 1 (12.9%) and Dim 2 (9%) collectively explain 21.9% of the variance, highlighting the key factors differentiating farming practices and farmer characteristics.

The Multiple Correspondence Analysis (MCA) was combined with hierarchical clustering to comprehensively understand farmer diversity. MCA was used firstly to reduce the dimensionality of our data. Then, the hierarchical clustering analysis was performed on these reduced dimensions to group farmers based on similarities across the analyzed variables (Figure 4).

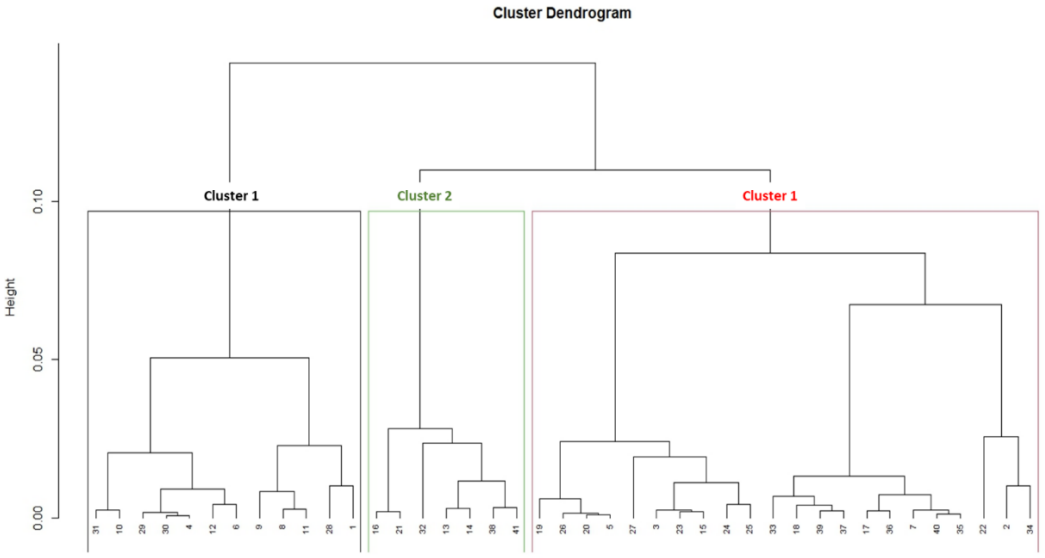

Figure 4: Dendrogram illustrating the hierarchical clustering of the 41 Ait ichou commune farmers. The dendrogram identifies three main clusters characterized by different farming practices and socio-demographic attributes.

The hierarchical clustering analysis categorized the farmers of Ait Ichou commune into three groups with distinct socio-economic and agricultural profiles (Figure 4 and Table 8).
Cluster 1 consisted predominantly of illiterate farmers with minimal formal education, managing smaller farms with an average cultivated area of 4.5 hectares, with fewer plots (1.75) and limited crop diversity (1.6 crops). The farmers in this cluster have minimal low levels of modernization and own a modest number of livestock. They depend mainly on agriculture as

their primary income source and utilize a combination of landraces and modern crop varieties, demonstrating a solid dependence on traditional agricultural practices.

Cluster 2 showed a higher level of educational farmers, with some members receiving secondary education. The farmers in this cluster manage larger farms, averaging 13.1 hectares, with a significantly greater number of plots (5.8 on average) and greater crop diversity (5.8 crops). They integrate landrace varieties with higher levels of modernization, a notable presence of trees (70.7), and higher livestock ownership, suggesting a progressive approach towards agriculture.

Cluster 3, representing the largest group, was similar to Cluster 1 regarding lower education levels and primary dependency on agriculture. The farmers, belonging to this cluster, manage moderately sized farms, averaging 8.5 hectares, and cultivate a balance of landrace and modern crop varieties, indicating a potential transition between traditional and modern farming practices. Furthermore, farmers in Cluster 3 maintain moderate livestock, which likely plays an integral role in their farming systems.

Table 8: Distribution of Farmers by Cluster and Socio-economic Characteristics

Socio-economic characteristics	**Clusters**		
	Cluster 1 (12)	**Cluster 2 (7)**	**Cluster 3 (22)**
Education Level (Number of farmers)			
Illiterate	8	3	19
Elementary			2
Primary school	1	1	1
Secondary school	2	3	
High school	1		
Average - Number of males resident on the farm	3.5	3.5	2.5
Average - Number of females resident on the farm	2.75	3.2	2.7
Incomes (Number of farmers)			
Agriculture	10	6	19
Agriculture + Other sources	2	1	3
Varieties (Number of farmers)			
Landrace and modern	8	1	11
Landrace only	4	6	11
Average - Number of Plots	1.75	5.8	3.5
Average - Number of crops cultivated	1.6	5.8	2.9
Average - Cultivated area (ha)	4.5	13.1	8.5
Average - Number of trees	0	70.7	7.4
Average - Plot owned	1.7	5.3	3.4
Average - Plot rented	0.08	0.8	0.2
Average - Modernization score	0.6	1.3	1.1
Average - Number of cattle owned	1.3	10.1	3.5
Average - Number of Sheep owned	18.7	70.8	25
Average - Number of Goat owned	11.5	14.3	9.8

Note: The number between parentheses indicates the number of farmers in each cluster.

4. Conclusion

The surveys conducted with farmers in Ait Ichou commune of Morocco revealed a resilient agricultural system characterized by small to medium-sized farms engaged in mixed farming practices. These farmers prioritize livestock production and crop cultivation, with a significant portion of their harvest dedicated to self-consumption, reflecting their strong connection to the land and a focus on food security.

The study also revealed that the farmers of Ait Ichou are active participants in the conservation and evolution of crop diversity. Their attachment to on-farm seed selection and production and informal seed exchange networks demonstrates a dynamic approach to maintaining and renewing their seed lots and varieties within their operations.

Despite the pressures of modernization and the potential for adopting standardized agricultural practices, these systems exhibit remarkable resilience. Farmers in Ait Ichou continue to adapt and innovate, ensuring the continued flow of genetic diversity and the preservation of traditional knowledge. This dynamic system demonstrates the importance of local knowledge and farmer's practices in maintaining a resilient agricultural landscape.

The findings of this study have important implications for conservation efforts and agricultural policy development. These implications could be summarized as follows:

- Supporting local knowledge: Recognizing and valuing the knowledge and practices of farmers like those in Ait Ichou is critical for sustaining agrobiodiversity.
- Strengthening farmers: Providing access to resources, training, and market opportunities supporting their traditional practices can strengthen their resilience and promote sustainable development.
- Investing in research: Further research on the specific mechanisms driving the dynamics of crop diversity in these systems is crucial for informing conservation strategies and supporting the development of innovative agricultural solutions.