Profiles and Practices of Farmers in The Commune of Andranomafana, Antsirabe Region

ANDRIAMANGA Nehemia Valisoa, Pr RAMANANARIVO Sylvain [1,2], Dr FARAMALALA Hilarion[3], Pr RAMANANARIVO Romaine[1,2], Pr RAZAFIARIJAONA Jules[1],

(1) Ecole Doctorale Gestion des Ressources Naturelles et Développement. EA Agro-Management, Développement Durable et Territoires, Université d'Antananarivo

(2) Ecole Supérieure de Management et d'Informatique Appliquée (ESMIA), Antananarivo, Madagascar

(3) Institut Supérieur de Technologie d'Antananarivo (IST), Antananarivo, Madagascar

ABSTRACT

Antsirabe is the leading potato-producing area and the top dairy producer, supplying neighboring zones and the entire country. It also benefits from three watersheds providing necessary irrigation and favorable pedoclimatic conditions for crops. However, development challenges remain, including land tenure security, product distribution across zones, and the collection and monitoring of product payments. Farmers in this area face particularly precarious living conditions. How can agricultural resources be optimized to improve farmers' living conditions in the short, medium, and long term? This study, conducted in Andranomafana (Betafo district), aims to identify obstacles to sector development for sustainable resource management. Semi-structured interviews with over fifty farmers were conducted using open questions in Malagasy. Interaction analysis and influence-dominance ordering were applied to identify internal factors. Data were first processed using Multiple Correspondence Analysis (MCA) to determine farmer profiles based on production factors. Benchmarking was then performed to evaluate current management practices against ideal scenarios. Correlation analysis revealed that farm size, labor use, and equipment are the main production factors, interacting in this order. Results identified two classes of producers. Benchmarking showed that both classes are far from ideal management practices. Agriculture remains the main local activity; while some farmers earn a decent income, others remain subsistence producers.

Keywords: *resource management, internal environment, external environment, Betafo*

INTRODUCTION

Agriculture holds a significant place in the country, both in terms of its economic and cultural value. Madagascar has strong agricultural potential. Indeed, the country has 1,516,819 hectares of irrigated land (Garruchet et al., 2023). Moreover, 83% of rural households make up the Malagasy population, and "even in urban areas, agricultural households represent 46% of all households" (Ministère des Affaires Etrangères, 2022). While the Malagasy population regularly consumes agricultural products such as rice, vegetables, and fruits in their raw form, each region of the country offers specific products. This is the case for the city of Antsirabe, which is the second industrial city in the country (Ministère des Affaires Etrangères et al. 2022).

The Vakinankaratra region is renowned for its agricultural products. The majority of vegetables sold in Antananarivo come from this area. The primary sector therefore plays an important role in the daily life of the population living in this part of the country. "In 2005, 85% of the population worked in agriculture, including 80% in livestock farming, compared to 1.3% in manufacturing and 1.8% in services" (CMC Madagascar, 2017). Furthermore, the environment is favorable to agriculture. "The soil types, volcanic and ferralitic, offer the possibility of diverse agricultural activities" (Région Vakinankaratra, 2021), especially in the Ankaratra and Betafo areas (CMC Madagascar, 2017).

As a city with strong agro-pastoral potential, Antsirabe has been the subject of several studies. Various projects have also been carried out in rural areas. Data are available to understand the characteristics of the agricultural system. Information also exists regarding the evolution of production prices and market trends. These studies aim to understand the city, its strengths and weaknesses in economic, social, environmental, agricultural, and tourism aspects. However, little information is provided regarding the management methods of agricultural holdings.

Hence the following contradictory reality arises: previous research presents Antsirabe as a city possessing the necessary environmental and economic assets for the development of the primary sector. Yet, farmers seem to live in difficult conditions. How then can agricultural resources be optimized to sustainably improve farmers' living conditions in the short, medium, and long term?

Facing this issue, the objective of this study is to identify levers to optimize the use of internal factors to ensure better resilience in the face of challenges in the agricultural sector. Two research questions are raised: What are the most influential or dominant internal production factors? And what are the current management methods of farmers and their impact on resource optimization?

Two hypotheses are proposed: optimizing the productivity of agricultural holdings relies on the interaction, organization, and hierarchy of internal factors; and farmers adjust their practices based on the available internal resources to optimize the use of these factors in their activities.

MATERIALS AND METHODS

1.1 Study Area Presentation

A field survey was conducted in the commune of Andranomafana, Betafo district, Vakinankaratra region. Located at coordinates 46°49'0" E, 19°49'0" S, this area is characterized by a strong agricultural dynamic, involving nearly 90% of the local population, according to the collected data.

1.2 Data Collection

To test the two hypotheses, a survey was carried out using a non-probabilistic quota sampling method among farmers. The sample size was calculated according to the sampling formula:

$$n = \frac{z^2\, p\,(1-p;)}{e^2} \quad ;$$

Where:

z represents the confidence level, set at 85%, corresponding to a value of 1.44

p corresponds to the estimated proportion of the concerned population, equal to 90% according to information collected from locals

e denotes the margin of error, defined as 5%

n is the sample size, obtained by numerical application of the formula, which is 78

The interviews were conducted in Malagasy to allow participants to express themselves clearly in their native language. The same variables were analyzed for both hypotheses: farm size, types of crops, equipment and products used, labor, and product sales methods.

1.3 Data Organization

A database was created from the information collected during the interviews. The responses were transcribed into an Excel sheet with individuals in rows and variables in columns. The variables were coded to simplify data processing. (Table 1). Non-responses were assigned the value "Z," while selected responses were marked with the value "Y."

Table -1 : ***Variables Studied***

VARIABLES	CODIFICATIONS	UTILITY
Types of crops	$P_1 \ldots P_n$	INFLUENCE AND DOMINANCE ORDERING BENCHMARKING
Area	SP	
	SM	
	SL	
Equipment used	$E_1 \ldots E_n$	
Products used	$PR_1 \ldots PR_n$	
	MAO	

VARIABLES	CODIFICATIONS	UTILITY
Labor	MAN	

1.4 Approaches

1.4.1 Task Scheduling of Available Internal Resources

In order to verify the hypothesis that "the optimization of agricultural farm productivity relies on the interaction, organization, and hierarchy of internal factors," a scheduling process was carried out. It began with a Multiple Correspondence Analysis (MCA), followed by a Discriminant Factor Analysis (DFA), with the aim of structuring the data and generating a reliable correlation matrix among the different internal factors. To limit redundancies caused by the symmetry of this matrix, only the values above the main diagonal were retained. The next step consisted of identifying the relationships deemed significant, using a correlation significance threshold denoted by ρ. This threshold, calculated from the Student's t-test with a sample size of 78, was set at 0.219, according to the formula:

$$|\rho| > \frac{t_{\alpha=0,05}}{\sqrt{n - 2 + t^2_{\alpha=0,05}}}$$

with

t = Student's
t-test usually taken as 1.96 ≈ 2 and
n = sample size

Consequently, any absolute value of a correlation coefficient denoted "r" exceeding this threshold (0.219) was considered significant and marked with an "X" symbol, as in [if (abs(r) > ρ; "X"; "")]. For each variable, the total number of "X"s was counted. This score reflects the level of interdependence of the factor with the rest of the system. The factors were ranked in ascending order of this score, starting with those having the fewest significant links with others. This ranking was performed iteratively, removing at each step the factors already ranked in order to recalculate the relationships among the remaining variables until all variables were exhausted. Once all factors were ordered, the sequence was reversed: those identified as the most independent ended up at the bottom of the ranking, while those initially the most interdependent appeared at the top. This reversal highlights at the top the production factors that are most correlated and therefore potentially the most structuring in optimizing agricultural productivity.

1.4.2 Optimizing the Use of Available Internal Resources

Dominant and Influential Variables in the Strategic Rectangle

As part of the verification of hypothesis 2 «farmers adjust their practices based on the available internal resources in order to optimize the use of these factors in their activities" an analysis of the influence and dominance effects of internal factors was conducted to establish their priority order. This analysis relied on the same correlation matrix used for the scheduling process.

To avoid redundancy due to the symmetry of the matrix, only the values above the main diagonal were retained. Significant variables were selected based on a significance threshold adapted to the sample size (n = 78), corresponding to an absolute correlation threshold greater than 0.219. Consequently, any absolute value of a correlation coefficient denoted "r" exceeding this threshold (0.219) was considered significant and kept, while those below were removed, as in [if (abs(r) > ρ; "abs(r)"; "")].Once this selection was made, the values of each variable were aggregated row-wise to give L, and column-wise to give P, in order to establish the dimensions of the strategic rectangle. These sums respectively represent the active contribution of a variable to others (influence) and its sensitivity to other variables.

Multiple Correspondence Analysis

Multiple Correspondence Analysis (MCA) was the method used to verify Hypothesis 2, which states: "Farmers adjust their practices based on the available internal resources in order to optimize the use of these factors in their activities." This multivariate method reveals associations between variable modalities and the profiles of farmers, thereby facilitating the analysis of strategic adjustments.

Initially, variables and observations were sorted according to their factorial coordinates, divided into four categories: (+;+), (+;-), (-;+), and (-;-), which allowed the structuring of coherent classes. The mean of the observations' coordinates was then calculated to refine the understanding of internal relationships between factors. The interpretation of proximities is based on the angles formed by the vectors: an angle less than 90° indicates attraction or concordance between internal factors, while an angle greater than 90° signifies an inverse relationship or opposition.

Classes showing proximity relations were grouped, which helped better grasp the dynamics between farmers and their internal resources. Finally, the overall interpretation relied on these groupings and on the distribution of variables according to their angular position, in order to identify the main axes influencing the organization of agricultural practices.

Benchmarking Analysis

A benchmarking analysis was conducted to validate the hypothesis that farmers adjust their practices based on the available internal resources in order to optimize their use. This approach is based on a comparison of the classes derived from Multiple Correspondence Analysis (MCA) against a reference ideal, defined from the maximum value of each variable.

The first step consisted of establishing the "Ranking Function" matrix derived from Discriminant Factor Analysis (DFA), which served as the database for this analysis. Significant variables were identified according to their p-values, and only those with values below 0.05 were retained. To normalize the data, a rescaling was applied to negative values by subtracting the minimum of their respective range. Then, the values were relativized by relating them to the sum of their range, ensuring a coherent comparison between the different classes.

The reference ideal was defined as the maximum value obtained for each variable, thus representing the optimal situation to be achieved. A comparison of the classes against this ideal was performed using a radar chart, allowing visualization of gaps and identification of areas for improvement. The closer a class is to the ideal, the more its strategies are considered optimal. This methodology therefore enabled positioning the classes within a reference framework and defining the necessary adjustments to improve farm performance.

RESULTS

1.5 Hierarchization of Internal Factors in Agricultural Farms

The results indicate that small plot size ranks first as a production factor, followed by large plot size, labor, and other equipment. Modern techniques appear at the bottom of the hierarchy. The scheduling results (Chart-1) revealed that farmers adopt a specific strategy regarding the prioritization of production factors:

- Priority 1 is assigned to the exploitation of small plots (SP-Y).
- Priority 2 corresponds to the absence of selection of small plots (SP-Z).
- Priority 3 highlights the non-exploitation of large plots (SL-Z), the use of ox-drawn plows (E1-Y), and the non-use of hoes (E2-Z).
- Priority 4 indicates the exploitation of large plots (SL-Y), the absence of ox-drawn plows (E1-Z), and the use of hoes (E2-Y).
- Priority 5 reflects the non-use of the weeder (E3-Z) and the sickle (E10-Z).
- Priority 6 emphasizes the use of the weeder (E3-Y) and the sickle (E10-Y).
- Priority 7 is characterized by the non-use of the pitchfork (E6-Z), the rake (E8-Z), and the use of the local fertilizer Zezika Gasy (PR2-Y).
- Priority 8 concerns the use of the pitchfork (E6-Y), the rake (E8-Y), and the non-use of Zezika Gasy (PR2 Z).
- Priority 9 highlights the non-exploitation of medium plots (SM-Z), the non-use of the harrow (E4-Z), the use of imported industrial fertilizer Zezika Vazaha (PR3-Y), and the employment of external labor (MAO-Y).
- Priority 10 illustrates the exploitation of medium plots (SM-Y), the use of the harrow (E4-Y), the non-use of Zezika Vazaha (PR3-Z), and the absence of external labor (MAO-Z).
- Priority 11 reveals the non-use of the cart (E5-Z), watering can (E7-Z), knife (E9-Z), and container (E11-Z), as well as the non-use of the pesticide Pilva (PR1-Z) and urea (PR4-Z), accompanied by the absence of external labor (MAN-Z).
- Finally, Priority 12 corresponds to the use of the cart (E5-Y), watering can (E7-Y), knife (E9-Y), and container (E11-Y), as well as the use of the pesticide Pilva (PR1-Y) and urea (PR4-Y), alongside the employment of external labor (MAN-Y), highlighting an integrated agricultural strategy focused on productivity.

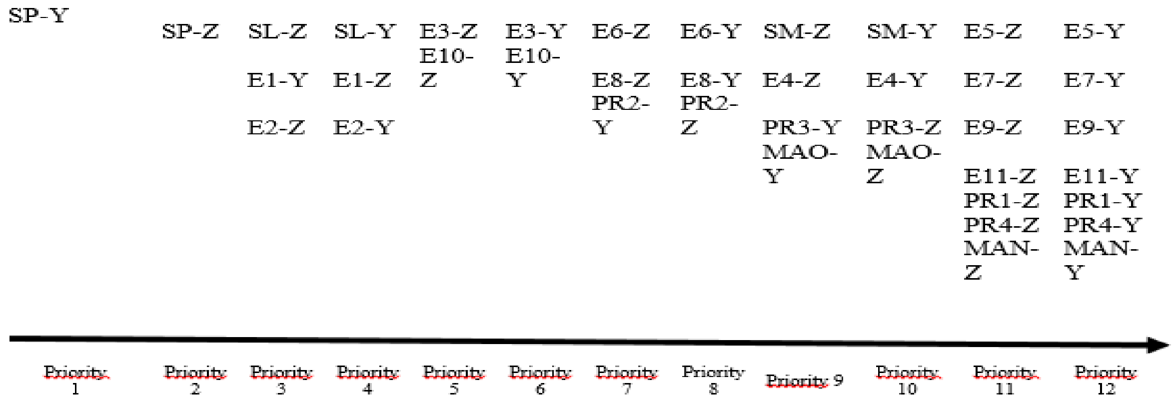

Chart- 1 : Ranking of Internal Production Factors

Legend : Small area (SP), Medium area (SM), Large area (SL), Agricultural equipment (E), Ox-drawn plow (E1), Hoe (E2), Weeder (E3), Harrow (E4), Cart (E5), Pitchfork (E6), Watering can (E7), Rake (E8), Knife (E9), Sickle (E10), Can (E11), Pilva pesticide (PR1), Local fertilizer (Zezika Gasy) (PR2), Imported industrial fertilizer (PR3), Urea (PR4), Without use of external labor (MAO), With use of external labor (MAN)

1.6 Profile and Performance of Agricultural Management Practices

1.6.1 Key Internal Factors

Table 2 highlights the dominant and influential variables:

- Dominant variables include weeder (E3-Z), the pitchfork (E6-Y), which is heavily utilized on farms as agricultural equipment. The use of external labor constitutes a key characteristic, distinguishing between those who do not employ workers (MAO-Z) and those who do (MAO-Y). The exclusion of small plot usage is also an influential variable (SP-Z).
- Regarding influential variables, tool usage varies significantly: the harrow (E4-Z), watering can (E7-Z), and knife (E9-Z) are infrequently used, whereas the pitchfork (E6-Y), bucket (E10-Y), rake (E8 Y), and ox-drawn plow (E1-Y) are favored. Medium-sized (SM-Z) and large (SL-Z) plots do not represent commonly used land categories. Some farmers utilize small plots (SP-Y). Some employ external labor (MAO Y), while others avoid it (MAO-Z). Both local fertilizer (PR2-Y) and imported fertilizer (PR3-Y) are frequently used for crop fertilization.

Table- 2 : Strategic rectangle

	Variables	X= L/P	Y=L*P
DOMINANT	E3-Z	1,27	9,44
	MAO-Z	1,01	8,90
	SP-Z	2,16	8,65
	MAO-Y	2,03	7,86
	E6-Y	1,14	7,45
INFLUENTIAL	SM-Z	1,16	6,71
	E1-Z	1,63	6,53
	E4-Z	1,26	6,44
	SL-Z	1,09	6,33
	E6-Z	2,51	6,10
	E2-Y	1,52	6,07
	SP-Y	5,33	5,33
	PR3-Y	1,18	5,24
	E10-Y	1,30	5,21

Legend :

Y	: Response	SL	: Large landholding	E4	: Harrow	SM	: Medium landholding
Z	: Non-response	E1	: Ox-drawn plough	E6	: Pitchfork	E3	: Weeder
SP	: Small landholding	E2	Hoe	MAO	: No reliance on external labor	PR3	: Imported chemical fertilizer (*Zezika Vazaha*)

1.6.2 Classification of Individuals Based on Their Characteristics

The Multiple Correspondence Analysis (MCA) identified two (2) distinct classes of individuals (Chart-2):

– **Class 1: Adaptive and Diversified Agricultural System (47%)**

Regarding cultivated crops, beans (P12-Y), carrots (P9-Y), zucchini (P16-Y), sweet potatoes (P17-Y), peanuts (P18-Y), cowpeas (P19-Y), and green beans (P21-Y) were selected, whereas others such as peas (P2-Z), maize (P1-Z), and tomatoes (P3-Z) were excluded. Concerning land tenure, respondents did not declare ownership (PT-Z) or a combination of ownership and rental (PL-Z). Renting alone (LT-Y) was the more common option, Additionally, land distribution showed a preference for small (SP-Y) and medium-sized (SM-Y) plots, while large farms were less represented (SL-Z). The use of agricultural tools showed a preference for the pitchfork (E6-Y), knife (E9-Y), bucket (E10-Y), and container (E11-Y), while equipment such as the hoe (E2-Z), rake (E8-Z), and harrow (E4-Z) were not used. Regarding product marketing, individuals were mainly present in Antsirabe (Can Y), Betafo (CB-Y), or other regions (CH-Y), whereas Anjazafotsy (CA-Z) and some other sites were less represented. They did not sell to collectors (CC-Z). Concerning input use, there was an absence of pesticide Pilva (PR1-Z) and urea (PR4-Z), and exclusion of local fertilizer (PR2-Z) and imported fertilizer (PR3-Z). Finally, in labor management, a significant portion of individuals chose to hire workers (MAO-Y), while another portion did not employ laborers (MAN-Z). They did not pay taxes (HO-Z) nor transport products themselves (TOZ).

– **Class 2: Structured and Optimized Agricultural System (53%)**

Regarding cultivated crops, maize (P1-Y), peas (P2-Y), tomatoes (P3-Y), radishes (P4-Y), potatoes (P5-Y), barley (P6-Y), and cabbage (P22-Y) were selected, whereas some crops such as sweet potatoes (P17-Z), green beans (P20-Z), and cowpeas (P19-Z) were excluded.In terms of land tenure, the majority of respondents opted for a combination of ownership and rental (PL-Y) or rental alone (LT-Y), while sole ownership (PT-Y) remained a secondary option. Regarding cultivated area, large plots (SL-Y) and medium-sized plots (SM-Y) were favored, whereas small farms were less selected (SP-Z).

Agricultural equipment use showed frequent use of the hoe (E2-Y), harrow (E4-Y), rake (E8-Y), and cart (E5-Y), while some tools such as the pitchfork (E6-Z), knife (E9-Z), and watering can (E7-Z) were less used. Concerning marketing, individuals were mainly present in Betafo (CB-Y) and Antsirabe (CA-Y), while Hafa (CH-Z) and other zones were less represented. Additionally, some identified themselves as collectors (CC-Y). Analysis of agricultural inputs showed frequent use of pesticide Pilva (PR1-Y), local fertilizer (PR2-Y), imported fertilizer (PR3-Y), and urea (PR4-Y).

Finally, regarding labor, the majority employed external workers (MAN-Y), in contrast to those who did not use external labor (MAO-Z). Concurrently, cooperative work was widely adopted (HO-Y), while some preferred a more individual approach (HN-Z).

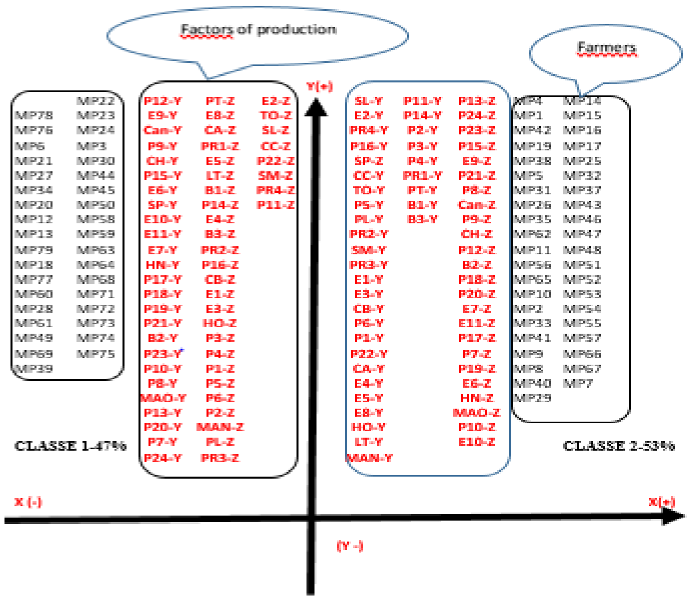

Chart -2 : Farmers' Typology Based on Internal Factors and Practices

1.6.3 Current Situation of Agricultural Producers

The benchmarking analysis (Chart-3) identified two classes, each representing a different situation relative to the ideal scenario:

- **Class 1 – Adaptive and Diversified Agricultural System:** The variables corresponding to the ideal criteria for this class are cassava (P7-Y), sweet potato (P17-Y), peanut (P18-Y), absence of selection for high profit (B3-Z), and non-use of the harrow (E4-Z).
- **Class 2 – Structured and Optimized Agricultural System:** The variables well aligned with the defined ideal are tomato (P3-Y), non-selection of radish (P4-Z), non-selection of maize (P10-Z), presence in Betafo for marketing (CB-Y), selection for medium profit (B2-Y), use of hired workers (HO-Y), and the use of ox-drawn plow (E1-Y) and weeder (E3-Y).

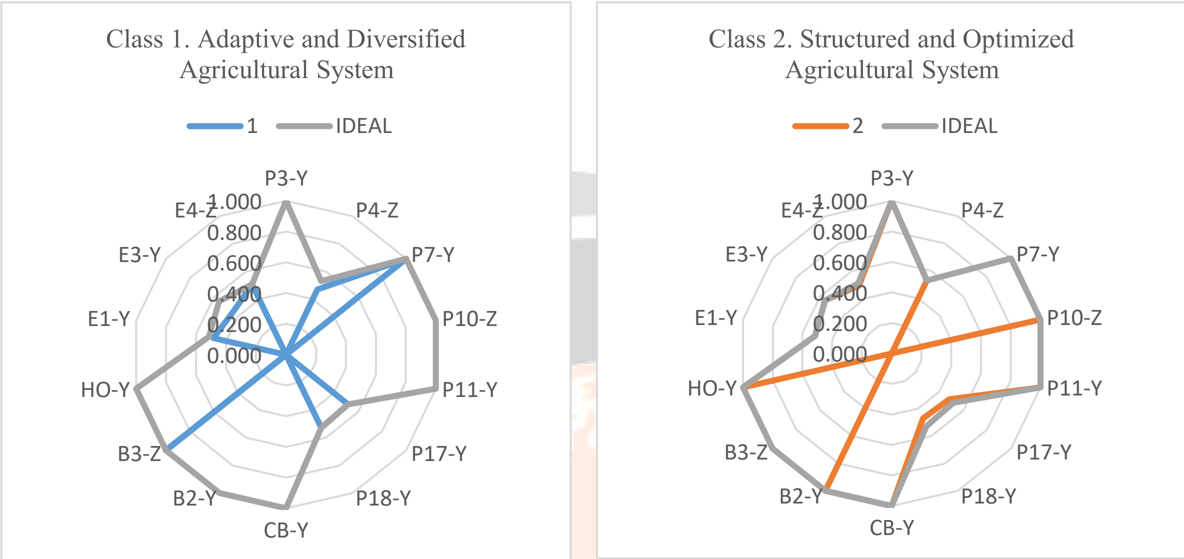

Chart- 3*: Benchmarking of the Current Management System of Agricultural Producers*

DISCUSSIONS

1.7 Priorization of Influential Internal Factors in Agricultural Holdings

"The lack of production factors (equipment, inputs, monetary cash flow, etc.) makes it difficult to increase production other than by expanding cultivated areas." (Mustapha Omrane, 2005). This observation highlights the importance of available resources in structuring agricultural practices. The results of the ordering (Chart-1) reveal a coherent management of farms, where farmers adapt their strategies according to constraints and available means. Production factors range from land access to the management of equipment, inputs, and labor use.

- **Priority 1-3:** Area constitutes a central lever in structuring production systems. Small farms (SP-Y) require rigorous parcel management, limit diversification, and demand maximal optimization of resources. Their equipment remains partially mechanized, as illustrated by the use of the ox-drawn plow (E1-Y), in the absence of hoes (E2-Z) and large areas (SL-Z). Conversely, the absence of small areas (SP-Z) indicates a focus on larger farms. Most farmers have land plots. Area determines technical choices, particularly access to equipment. Small areas compel intensification of production to generate margins necessary for investment in inputs and tools. Moreover, "agricultural activity generates low income and does not allow households to make the productive investments needed for the development of agricultural holdings." (Garruchet et al., 2023)
- **Priority 4-6:** Farmers on large areas (SL-Y) use hoes (E2-Y) without resorting to ox-drawn plows (E1-Z), reflecting an adaptation of practices to pedological or topographical constraints. The non-use of the hoe (E3-Z) and sickle (E10-Z) suggests the mai) by other farmers demonstrates a desire to increase work efficiency. These choices reflect progress in equipment, linked to the expansion of cultivated areas.
- **Priority 7-10:** The gradual introduction of inputs begins with the use of local fertilizer (PR2-Y), without mobilizing certain tools (E6-Z, E8-Z), signaling a transition towards enriched practices. The use of the fork and rake (E6-Y, E8-Y) reflects differentiation in farming logics. Furthermore, the non-exploitation of medium areas (SM-Z) and the harrow (E4-Z), combined with the use of imported fertilizer (PR3-Y) and labor (MAO-Y), illustrates system intensification. Conversely, the exploitation of medium areas (SM-Y) and the use of the

harrow (E4-Y), without imported inputs (PR3-Z) nor external labor (MAO-Z), indicate autonomous management, less dependent on external resources.

– **Priority 11 and 12:** The absence of light equipment (E5-Z, E7-Z, E9-Z, E11-Z), chemical inputs (PR1-Z, PR4-Z), and external labor (MAN-Z) reflects a low-mechanization model relying on alternative practices. Conversely, their mobilization (E5-Y, E7-Y, E9-Y, E11-Y, PR1-Y, PR4-Y), combined with autonomous labor management (MAN-Y), characterizes an integrated strategy aiming at intensification and optimization of available resources. Unlike previous priorities focused on autonomy, this phase illustrates a logic of maximized yield.

Thus, as the cultivated area expands, the needs for equipment and inputs increase, reflecting farmers' progressive adaptation to the demands of agricultural production. Investment occurs gradually, first by enlarging land, followed by progressive mechanization of methods. It is particularly notable that after parcel expansion, farmers do not immediately opt for mechanized equipment but first favor manual tools before investing in more advanced equipment (Priorities 3-4, then 9-10), illustrating thoughtful and structured resource management.

The same logic applies to inputs: local fertilizers are used first, with imported fertilizers integrated at a more advanced stage of the production process. Finally, once farmers have a sufficient number of tools, they gradually reduce reliance on external labor (Priority 12), reflecting a pursuit of efficiency and optimization of agricultural work. This progressive approach highlights a coherent investment strategy, where each step is designed to strengthen productivity while minimizing economic risks linked to too rapid a transition. (FAO, 2016)

1.8 Rethinking Internal Resources for Optimization in Farmers' Practices

1.8.1 Consideration of the Key Internal Factors

Table- 2 highlights three dominant factors in the studied agricultural holdings: labor use (MAO), small plot size (SP), and equipment. These results reflect the field reality and emphasize the challenges faced by farmers. Labor remains a central element in a system where mechanization is still limited (Ministère de l'Agriculture, 2015). Farmers adjust their management based on labor availability and cost, which directly influences their productivity.

Plot size also conditions agricultural practices. The smaller the area, the more farmers must maximize the use of available resources to achieve the best possible yield. This constraint also affects crop diversification, limiting alternatives for producers. Finally, the predominance of the fork (E6) equipment reflects a lack of mechanization and reliance on rudimentary tools. Limited access to efficient equipment impacts the effectiveness of agricultural practices and restricts productivity gains.

Agricultural practices are largely influenced by farmers' experience and knowledge passed down through generations. Each farmer adapts their methods according to available resources and encountered constraints. The ox-drawn plow (E1), rake (E8), bucket (E10), and local or imported fertilizers (PR2, P) are among the influential variables. These elements testify to farmers' rootedness in traditional practices, highlighting low adoption of modern techniques. Resistance to change is explained by attachment to methods inherited from previous generations, limited land availability, and low investment capacity (DELILLE, 2011).

Moreover, lack of financing limits their ability to invest in more efficient equipment. Access to agricultural credit remains complex, with restrictive conditions that hinder practice evolution and obstruct farm modernization (HAVARD et al., 2016).

These results illustrate both the difficulties faced by farmers and the importance of optimizing internal factors. Improving working conditions, notably through increased access to modern equipment and better-adapted cultivable land, appears as a priority to strengthen farm viability and improve producers' living conditions. Internal production factors are crucial for optimizing yields. Indeed, production depends on these factors: the more optimized they are, the higher the potential production. Conversely, the lack or poor optimization of these factors negatively impacts production. "The lack of production factors (equipment, inputs, monetary cash flow, etc.) makes it difficult to increase production" (Mustapha Omrane, 2005).

1.8.2 Adapting Practices to Available Internal Resources

Chart-2 distinguishes two classes of individuals according to their responses. The majority of farmers have a plot size less than or equal to half a hectare (Di Hadrien, 2021). This land fragmentation is explained by successive inheritance divisions, a process that gradually reduces plot sizes. "From generation to generation, rural farmers in the Highlands transmit an increasingly limited land heritage, often without legal coverage due to an inadequate administrative framework for land management" (Mustapha Omrane, 2005). Roberto (2020) confirms that "family farms barely total more than one hectare on average" and that households own on average four plots, limiting production.

Crops vary according to classes, soil needs, and available resources. Each farmer chooses their productions based on the equipment they can mobilize. Class 1 is characterized by a diversity of crops grown, associated with a targeted selection of tools according to local constraints. The exploitation of small plots (SP-Y) involves the use of versatile and accessible tools, such as the fork (E6-Y) and the knife (E9-Y), adapted to the specific needs of manual labor. The archaic nature of this equipment leads progressively to increased labor mobilization (MAO-Y) to compensate for the lack of mechanization. This model relies more on adaptability to agricultural conditions than on a formal structure of an optimized production system. Farmers face several constraints: (i) small plot size limits yields, and (ii) equipment necessary for better productivity remains inaccessible to many due to high costs. As Omrane (2005) points out, “the lack of production factors makes it difficult to increase production other than by expanding areas.”

Class 2 is characterized by broader access to agricultural equipment and a more targeted selection of crops, which favors production optimization and quality improvement. Farmers adopt a methodical approach, integrating specific tools to maximize efficiency. The use of the ox-drawn plow (E1-Y) and the hoe (E3-Y), essential mechanical equipment, reflects a desire to reduce the hardship of manual labor while improving productivity. This strategy has enabled them to achieve an average profit (B2-Y), reflecting better farm profitability.

This situation creates a vicious circle. The majority of farmers practice subsistence agriculture focused on the short term. Only those in class 2 manage to generate significant profits. Sales concentrate on local markets, while distance and transport costs hinder access to larger markets such as Antsirabe. In the short term, these sales meet household needs, but in the long term, intensive farming causes negative impacts such as “erosion and reduction of available land” (Mustapha Omrane, 2005).

During surveys, it was observed that some farmers sell part of their harvest only to buy back products later, highlighting their precarious situation. Their resistance to change, linked to attachment to family and cultural traditions, slows the adoption of new methods. “Land, with its dual ancestral and economic dimension, often remains property passed down unchanged and is poorly perceived when exploited by outsiders” (Mustapha Omrane, 2005). Influenced by these traditions, farmers favor survival-oriented management rather than profitability.

Land tenure challenges and resistance to change hinder efforts to improve agricultural management practices.

1.8.3 Current Situation of Farmers Relying on Internal Resources

The results highlight significant distinctions between classes, each adopting a specific management strategy relative to the defined ideal. This classification reveals differentiated approaches influencing farm productivity and viability.

Chart-3 revealed the existence of two classes of farmers. The variables retained from the benchmarking analysis showed that only those related to products are significant. Mechanized farmers on leased land (class 2) appear as the model closest to the ideal. Their approach is based on choosing adapted crops and investing in equipment that improves efficiency. Here, mechanization does not mean the use of motorized tillers but rather tools such as machetes and sickles. The combination of these tools with optimized management of production factors directly contributes to farm performance. Farms mainly use manual tools (hoe, sickle, machete), while animal traction and intensive systems remain underdeveloped. The low possession of hoes, weeders, and sprayers reflects limited use of mechanization and pesticides, highlighting an agriculture still largely traditional (DABAT et al., 2010). Class 1 is particularly vulnerable due to crop diversification without true rationalization of product choices. These farmers primarily rely on labor intensification among production factors, at the expense of investments that could improve profitability and sustainability.

Another major challenge concerns learning. Although training projects are in place, low literacy rates (67.8% in rural areas versus 83.7% nationally, according to RASOARAHONA et al., 2014) complicate knowledge appropriation, particularly in resource management. Consequently, adoption of improved techniques and inputs remains low, exacerbated by insufficient extension and training services. As these researchers observed, “the strong influx of new entrants into the labor market each year, due to population growth and school dropouts, makes reflection on their integration essential. Strengthening literacy, education, and vocational training is indispensable, as the agricultural sector remains the main provider of employment.”

CONCLUSION

The study's objective was to identify the obstacles to the development of agricultural holdings. To achieve this, the analysis first focused on their cropping systems. Secondly, the study identified the difficulties encountered. Knowing the development barriers helps implement levers for sustainable improvement in farmers’ lives.

Hypothesis testing revealed that farmers mainly aim to produce to survive. They do not prioritize improving their livelihoods. The first hypothesis "optimizing agricultural productivity depends on the interaction, organization, and hierarchy of internal factors" was confirmed. Farmers still operate in a subsistence mode. Hypothesis 2 was also partially confirmed: "farmers adjust their practices based on available internal resources to optimize factor use in their activities." None of the farmer groups fully correspond to the ideal situation. However, each class exhibits variables aligned with the ideal situation. Farmers adopt a cropping system that allows them to survive.

The study shows that farmers with structured systems gain better profits than those adapting without a defined framework. Notably, some farms still operate on a subsistence basis, seeking to evolve while adapting to environmental constraints. The analysis also highlights that a more rational and organized approach could significantly improve their living conditions.

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