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Agricultural profiles and priority needs of producers on Madagascar's eastern coast

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Abstract

On the eastern coast of Madagascar, farms rarely depend on a single agricultural activity. Households combine food crops, cash crops, fruit production, and, in some cases, fishing and livestock farming under strong climatic constraints and uncertain market conditions. This study aimed to identify profiles of agricultural practices and rank producers' priority needs in order to better understand farm decision-making logic and support better-targeted interventions. Two questions guided the analysis: which profiles emerge from the combination of observed practices, and which needs occupy a central position according to producers? A systemic approach was adopted, based on a cross-sectional survey of 395 households. Agricultural practices, coded as binary variables, were analyzed using multiple correspondence analysis, followed by hierarchical cluster analysis and discriminant analysis to test class robustness. Farmers' needs were extracted from a corpus of open-ended responses, converted into a lexical matrix, and then ordered using a matrix of significant correlations presented as a Program Evaluation and Review Technique (PERT) diagram. The results identified three contrasting producer profiles and revealed a hierarchy of needs structured around productive capacities, access to finance, and marketing conditions. These findings highlight the value of combining typological and network-based approaches and provide a basis for better-targeted agricultural interventions in eastern Madagascar.

Keywords: Benchmarking; Diversification; Prioritization; Rural strategies; Agroforestry

1. Introduction

Globally, agricultural transformation is currently shaped by climate variability, urbanization, and changing market structures. The literature on agricultural innovation systems describes bottlenecks linked to the relationships between research, extension, finance, and market outlets. It also highlights the importance of agreements among stakeholders regarding priorities, the sequencing of support, and targeting rules [1, 2]. Reviews of climate-smart agriculture report potential gains in productivity and sustainability, while also pointing to major constraints, including transition costs, perceived risks, poorly adapted technical packages, and land tenure and credit limitations [3, 4]. These constraints vary across farms. Such heterogeneity supports an approach based on observed configurations rather than on a single farm model.

In sub-Saharan Africa, the vulnerability of family farms is associated with dependence on rainfed agriculture, limited access to productive resources, and exposure to multiple shocks, resulting in highly diverse trajectories [5-7]. In the Indian Ocean region, findings from the Comoros indicate that households are highly sensitive to crises and trade disruptions [8]. In Madagascar, these factors are compounded by difficulties in coordinating interventions over time [9], disruptions to value chains during the COVID-19 period [10-12], and land constraints that limit investment and collective management [13].

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Farm typologies help make this diversity more interpretable, but their construction varies considerably. Data-driven approaches generate reproducible groupings, yet they remain sensitive to coding choices, distance measures, and cut-off rules, which continues to fuel debate about comparability across studies and their usefulness for action [14-16]. A persistent tension remains. Typologies must be sufficiently synthetic to inform advisory services and planning, while still reflecting the diversity of practice portfolios, especially when variables are binary and only capture presence or absence, without measuring area or intensity.

In the Malagasy context, favorable signals coexist with persistent constraints. Reviews of agroforestry report ecological and socio-economic benefits, with marked variation across territories and households [17]. Other studies link livestock keeping to household food security and children's dietary diversity [18]. However, seasonal food insecurity and malnutrition remain high in several rural areas [19], and wild resources continue to play an important role during the lean season [20]. In the North-East, perceptions of climate change are common, but reported adaptation remains limited [21]. In the South, the gap between project designs and observed trajectories has led researchers to place local context at the center of diagnostic processes and support choices [9, 22].

Against this background, the present study focuses on identifying profiles of agricultural practices and farmers' needs in order to understand the operating logic of production systems and to guide interventions more appropriately. The study addresses two research questions: (i) which producer profiles emerge from the combination of observed agricultural practices? and (ii) which needs occupy a central position according to producers? To answer these questions, two hypotheses are proposed: (i) the combination of agricultural practices generates distinct farmer profiles; and (ii) producers give priority to needs related to productive capacities and marketing conditions.

2. Material and methods

2.1. Study area and data collection

The study covered the eastern coast of Madagascar, within the contiguous Regions of Analanjirofo and Atsinanana (16°30′00″ S to 19°30′00″ S; 48°50′00″ E to 49°40′00″ E), over an area of approximately 44,000 km^2. The study area includes coastline, rice-growing plains, and foothills under a humid tropical climate with high rainfall. Cyclones and flooding occur recurrently and affect access to plots, the condition of rural roads, and decisions regarding the agricultural calendar.

Data were collected through a standardized questionnaire administered in face-to-face interviews with producers in a cross-sectional design. Sample size was determined using Cochran's formula: $n = (z^2\hat{P}(1-\hat{P}))/e^2$, with $z = 1{,}96$ (95%), $\hat{P} = 0{,}5$ and $e = 0{,}05$, yielding 384 households. To account for non-response and questionnaire completion errors, 395 household questionnaires were administered and retained. Data were collected between March 2024 and April 2024. The questionnaire was administered in Malagasy.

2.2. Typology of agricultural practices and benchmarking

A multiple correspondence analysis was performed on an individuals × variables table composed of binary qualitative variables describing agricultural practices. Each variable took the value "Yes = 1" when the practice was reported for a given individual and "No = 0" otherwise. Producer profiles were first explored on the multiple correspondence analysis factorial plane and then consolidated by hierarchical cluster analysis. Agreement between the exploratory grouping and the hierarchical cluster analysis solution was assessed using a chi-square test and Pearson's Phi coefficient.

The test was significant, and Pearson's Phi correlation coefficient was 0.9693. To characterize each class, discriminant analysis was carried out using the classes derived from the hierarchical cluster analysis as the qualitative dependent variable to be explained. Discriminant analysis first evaluates overall separation and then the discriminant contribution of each binary indicator. When necessary, an iterative reclassification procedure uses posterior probabilities to stabilize the confusion matrix; the best iteration is retained. For each significant variable, class-specific classification functions are extracted, and these values are then relativized into a stochastic matrix, making it possible to define the maximum reference value for each variable. The variables are subsequently presented as radar charts for benchmarking purposes.

2.3. Ordering of producers' needs

Producers' needs were identified through discourse analysis. This approach consisted of deriving, from open-ended responses, a space of needs expressed by producers and then ranking these needs according to the structure of their correlations. The unit of analysis was the individual: all textual responses were grouped into a single "document" attached to each surveyed person. The documents were then segmented using usual separators in order to extract lexical units. The vocabulary V corresponds to the set of distinct words effectively observed in the corpus.

The frequency matrix $F \in N^{N \times V}$ was constructed such that, for every individual i and every word $t \in V$, the cell $F_{i,t}$ equals the number of occurrences of t in individual i's document. This operation follows the "bag-of-words" approach and produces a set of numerical variables that can be directly used for correlational analysis.

From F, a correlation matrix R was calculated for all pairs of retained lexical variables. The calculation was performed in XLSTAT using the selected frequency columns. The significance of a correlation was assessed at the α = 0.05 threshold. The critical correlation threshold, denoted r_c, is defined as:

$$r_c = \frac{t_{1-\alpha/2,\, n-2}}{\sqrt{(n-2) + t^2_{1-\alpha/2,\, n-2}}}$$

where n denotes the number of observations and $t_{1-\alpha/2,\, n-2}$ is the quantile of the Student's t distribution with $n - 2$ degrees of freedom. A binary matrix B is then constructed such that: $B_{ij} = 1$si $|\, r_{ij}\, | \geq r_c, B_{ij} = 0$ otherwise.

This transformation makes it possible to identify statistically significant associations between lexical variables.

The ordering of variables was then performed in Excel. For each variable j, the degree of significant connection to the network was defined as $S_j = \sum_i B_{ij}$. The variable with the lowest $S_j$value was removed; the corresponding matrix was then updated by deleting the associated row and column, and the operation was repeated iteratively until all variables had been exhausted. The elimination order produces an inverse ranking: the first variables removed are the least connected, whereas the last are the most interdependent. This order provides an interpretable hierarchy of expressed needs without inferring causality.

For interpretation, the list used was already reversed: the first rank corresponds to the variables having the largest number of significant correlations with the others, and increasing ranks then correspond to decreasing connectivity.

The results were presented as a Program Evaluation and Review Technique (PERT) diagram constructed from the binary matrix B. The PERT structure follows the ordering levels and retains, for each target variable, a single incoming link defined as the significant correlation with the greatest absolute intensity, $|r|$, originating from a more connected level. Arrows are directed from a more connected level toward a less connected level. Line style indicates the sign of the correlation: a solid line if $r > 0$ and a dashed line if $r < 0$.

3. Results

3.1. Agricultural practices based on multiple correspondence analysis and typology

The symmetric variable plot derived from the multiple correspondence analysis shows the distribution of modalities on the F1–F2 plane (Figure 1; Figure 2). The plane accounts for 56% of the total inertia (F1 = 39%, F2 = 17%).

The multiple correspondence analysis identified three classes:

3.1.1. Class 1: food crop–cash crop system (13%)

The profile of Class 1 is characterized by an agricultural system combining food crops and cash crops. The food base relies mainly on potatoes (potato-1) and sweet potatoes (Sweet_potato-1). Cash crops are also prominent, particularly cloves (clove-1), coffee (coffee-1), and vanilla (vanilla-1). Turkey farming (Turkeys-0) is absent in this group. Some crops, such as raffia (Raffia-1) and ginger (Ginger-1), are also present in the agricultural practices of this class.

3.1.2. Class 2: diversified food crop–livestock system (61%)

The profile of Class 2 is based on a food-crop system structured around rice (Rice-1) and cassava (Cassava-1), with livestock clearly present. Poultry is the most common enterprise (Turkeys-1, Chickens-1, Geese-1, Ducks-1), whereas cattle (Cattle-1) and pig (Pigs-1) rearing are present without constituting the core of the profile. Perennial cash crops such as clove, vanilla, coffee, cinnamon, as well as pepper and raffia, are generally of limited importance. Sweet potato (Sweet_potato-1) and potato (potato-0) are most often absent.

3.1.3. Class 3: low-diversification system (26%)

The profile of Class 3 is characterized by the absence of livestock farming (No_livestock-1). From an agricultural perspective, production appears more fragmented. Rice and cassava cultivation do not systematically structure this profile, while the absence of maize (Maize-0), sugarcane (Sugarcane-0), and many fruit trees (Lychee-0, Orange-0, Banana-0, Papaya-0) is dominant. Only avocado (Avocado-1) and coconut (Coconut-1) emerge as crops associated with this class.

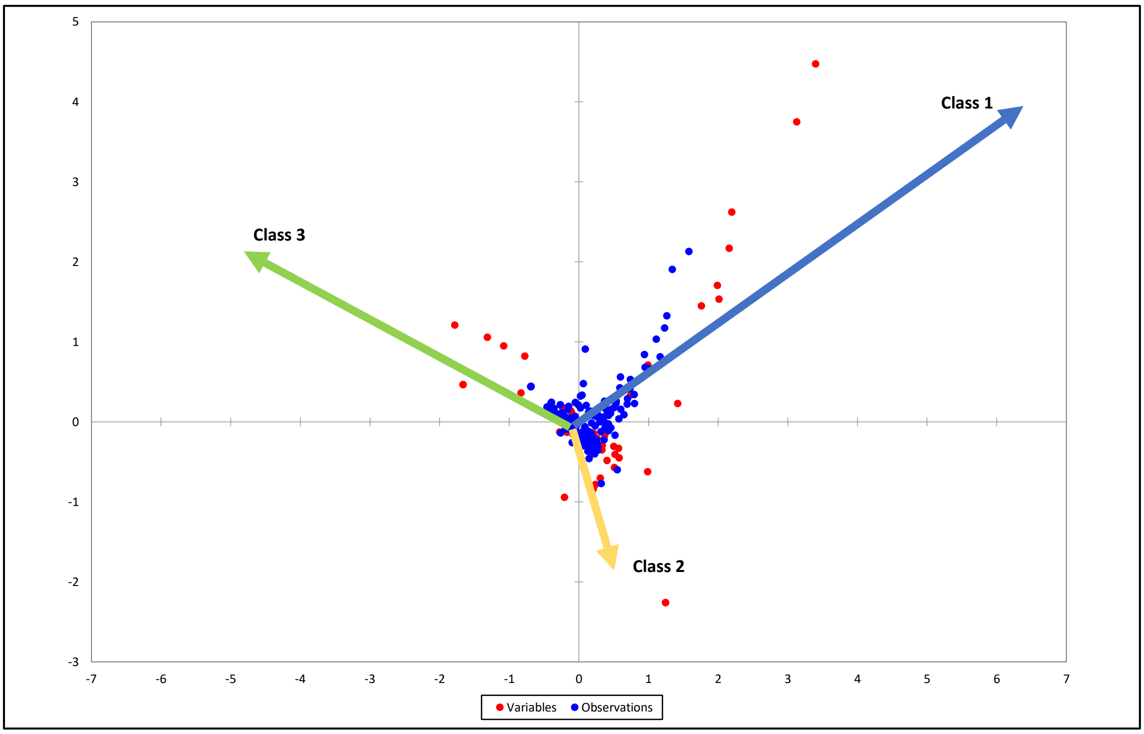

Figure 1 Symmetric multiple correspondence analysis plot of agricultural practices

Classe 3 : low-diversification system (26%)						Classe 1 : food crop–cash crop system (13%)			
No crops-1	9	90	299	254	301	25	355	277	Pepper-1
No livestock-1	70	169	303	255	162	78	91	99	Raffia-1
Avocado-1	127	215	317	298	247	264	142	121	Ginger-1
Coconut-1	156	251	350	312	40	88	362	297	Potato-1
Cassava-0	157	258	357	313	193	270	81	104	Cinnamon-1
Maize-0	164	259	391	316	217	31	368	343	Coffee-1
Ducks-0	176	308	248	319	294	101	288	161	Vanilla-1
Cattle-0	177	394	5	320	295	128	20	346	Sweet potato-1
Pigs-0	178	395	12	323	369	102	372	131	Clove-1
Fishing-0	180	273	23	337	260	113	314	100	Other fruits-1
Geese-0	181	304	60	342	344	170	289	82	Turkeys-0
Lychee-0	182	67	93	18	148	118	208	209	
Orange-0	184	13	107	24	165	8	179	309	
Banana-0	211	77	122	36	290	325	48	238	
Other vegetables-0	240	249	166	94	306	356	124	352	
Sugarcane-0	241	335	239	95	4	280	201		
Papaya-0	242	339	261	111	11	279	191		
Endive-0	243	340	345	140	42	373	275		
Rice-0	245	348	41	146	336	358	371		
Chickens-0	252	15	246	45	338				
			195	194	363				

Classe 2 : diversified food crop–livestock system (61%)								
Other fruits-0	253	110	333	216	80	53	272	327
Ginger-0	257	155	341	218	125	144	65	334
Raffia-0	152	10	376	367	271	282	278	365
Potato-0	75	89	377	175	33	347	287	267
Pepper-0	305	14	378	219	199	353	292	2
Sweet potato-0	250	381	382	220	57	354	383	7
Cinnamon-0	307	6	145	167	200	359	384	17
Vanilla-0	387	16	173	21	230	360	39	22
Clove-0	147	26	204	225	291	361	35	30
Coffee-0	214	27	224	311	105	385	265	86
Turkeys-1	310	29	366	318	112	207	386	139
Avocado-0	76	54	172	321	115	205	74	296
Coconut-0	151	55	237	276	137	231	79	374
No crops-0	160	62	284	330	183	234	158	3
Cassava-1	171	64	380	202	132	212	244	38
Rice-1	19	68	153	59	136	159	72	150
No livestock-0	109	69	154	66	141	213	236	123
Banana-1	223	85	73	222	226	32	37	87
Pigs-1	268	98	196	44	143	61	134	393
Chickens-1	274	108	197	50	56	34	168	1
Endive-1	283	129	174	52	97	51	210	269
Geese-1	285	138	163	96	235	286	221	46
Maize-1	293	185	84	116	370	349	228	114
Ducks-1	302	187	47	117	266	388	300	126
Cattle-1	315	188	329	130	281	389	364	232
Papaya-1	322	189	392	133	233	390	379	198
Sugarcane-1	324	227	332	135	71	63	28	206
Fishing-1	326	229	83	149	190	203	49	192
Other vegetables-1	328	256	103	43	120	375	119	92
Lychee-1	331	263	262	58		351	186	106
Orange-1	370	266	281	233		71	190	120

Figure 2 Agricultural practices according to multiple correspondence analysis

3.2. Benchmarking of agricultural practices by class according to discriminant analysis

Wilks' lambda from the discriminant analysis indicates clear discrimination between classes, with $p < 0.0001$ at the $\alpha = 0.05$ threshold. The benchmarking derived from this discriminant analysis feeds the radar representation of the three classes and the ideal curve representing the envelope of the maximum values for each variable.

Class 1 groups producers associated with a combination of food crops and perennial crops, with a marked presence of several cash crop enterprises (Figure 3). The profile simultaneously shows contributions from selected absence indicators and specific animal activities. All variables approach the maximum on several food-crop and perennial-crop axes, while showing depressions for several crop-absence indicators and for some animal species: Cattle-0, Pigs-0, and Fishing-0.

Class 2 is characterized by a few specific crop absences (Coffee-0; Pepper-0; Papaya-0) and an intermediate position on practices shared with another class (Figure 4). Departures from the maximum are observed for most cash crops (Vanilla-1; Clove-1) and for the majority of livestock indicators, except for the chickens (Chickens-1).

The profile of Class 3 is distinguished by peaks for several crop absences (Figure 5). The curve remains close to the maximum for a series of axes related to crop absences (Sweet_potato-0; Potato-0; Cinnamon-0; Pepper-0; Avocado-0) and contracts on livestock indicators and several food crops, giving it contrasting variables compared with the other classes.

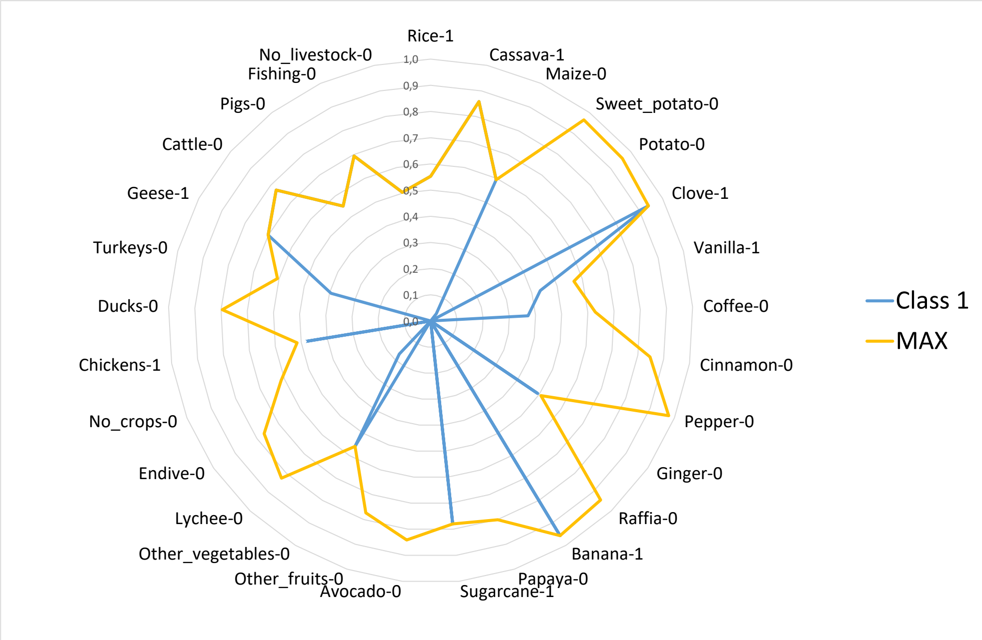

Figure 3 Benchmarking of cropping practices: Class 1 - food crop–cash crop system

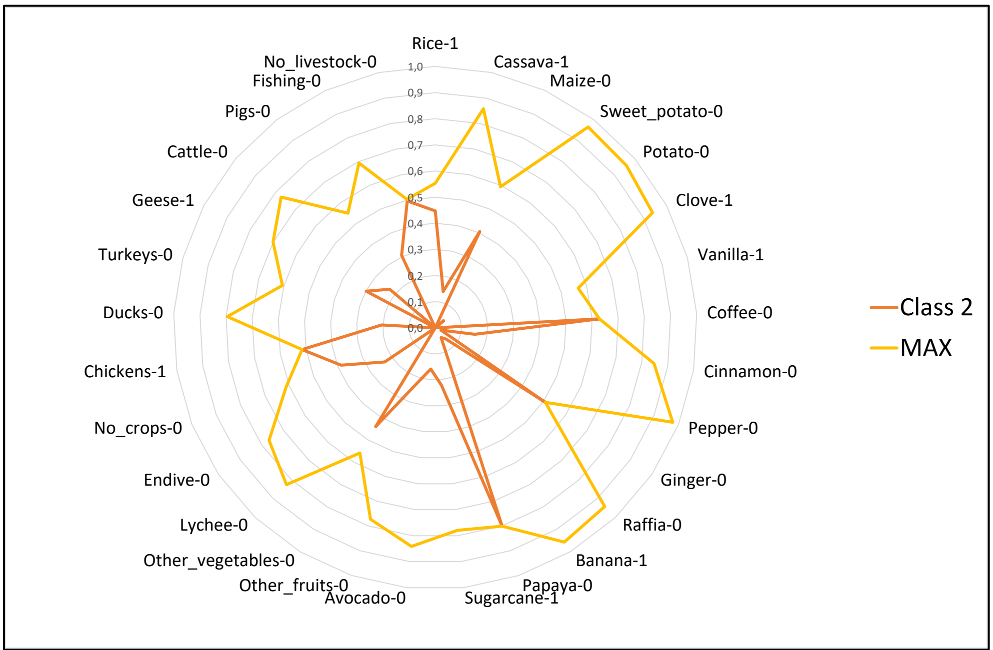

Figure 4 Benchmarking of cropping practices: Class 2 - diversified food crop–livestock system

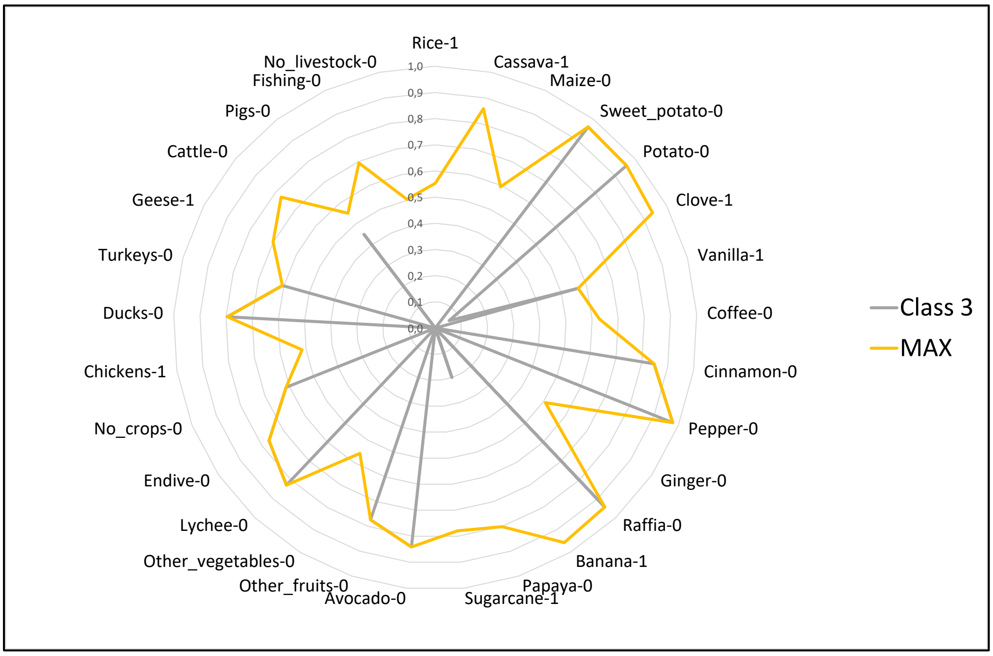

Figure 5 Benchmarking of cropping practices: Class 3 - low-diversification system

3.3. Ordering of producers' needs

Three entry points structure the network: training, agriculture and supplier (Figure 6). The network attached to training links production/yield, then distributes several branches: canal, increase, equipment, hoe, fertilizer (negative link), problem, cattle/zebu, association/cooperative, capacity to carry out, entrepreneur, and place/site toward waiting time and reserved/dedicated. From waiting time, one branch leads to seeds, then to cinnamon, demand, and wood/tree. Another branch leads to food, then to work, with two outputs: flooding (negative link) and legal compliance, which extends toward food stocks/edible agricultural products and ease/affordability. The food segment also links tools, autonomy, rain, then purchase and support toward heavy rain. Finally, production/yield is linked to product prices and improvement, then to heat/temperature, monitoring, cyclone, and livestock farming.

The network attached to agriculture follows the chain land/tenure, money, and assistance. The network attached to supplier follows the sequence sufficiency and household, then branches toward livelihoods and the marketing chain. Another branch links household to implementation, then to variability and weather/climate. From weather/climate, one branch leads to daily life and then to coping. A second branch leads to all year round, then to buying/purchase, with two outputs toward construction/repair and life. The same sequence also passes through all year round and rice, then to clove, cassava, mechanical weeder, and sale/trade. Finally, implementation is also linked to drought.

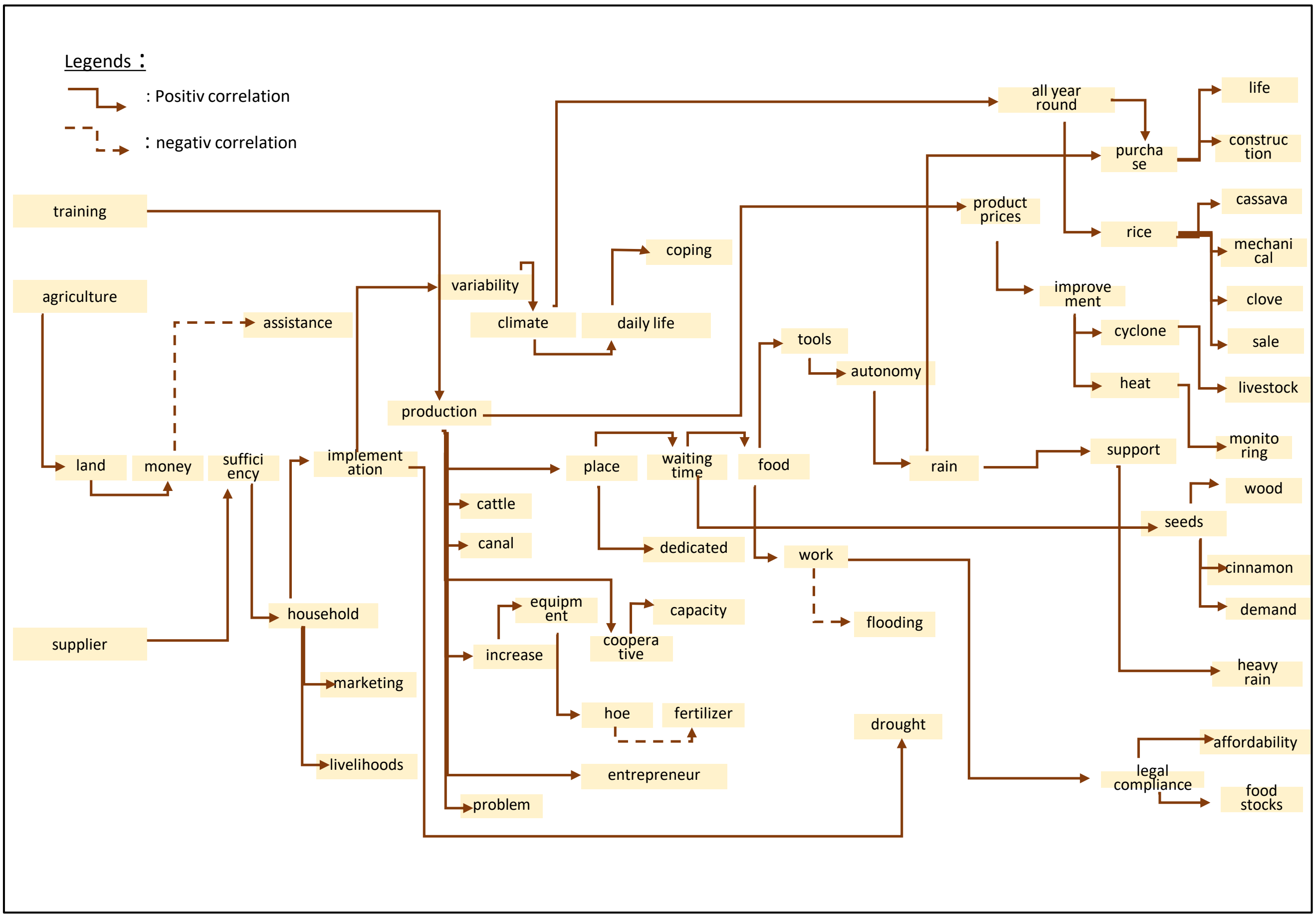

Figure 6 PERT diagram of producers' needs based on significant correlations among lexical variables

4. Discussion

4.1. Diversified profiles of producers

4.1.1. Food crop–cash crop system

On the factorial plane (Figure 2), Class 1 is located on the side of modalities associated with cash crops and tree-based systems. The benchmarking analysis assigns this profile a strong contribution from cassava and clove production, together with a clear contribution from banana and sugar cane cultivation. The radar representation therefore reflects a configuration supported by a core set of plant productions that combine a food-crop base with agricultural cash crops. This configuration is consistent with agroforestry systems described in eastern and northeastern Madagascar, where cash crop structures land use and integration into value chains [17]. Comparable typology-based approaches aimed at adapting advisory services have also been developed in East Africa. In Rwanda, for example, an action-oriented farm typology has been used to target inputs and support according to crop–livestock combinations [16].

Descriptions of agroforestry mosaics in eastern Madagascar, characterized by combinations of perennial crops and associated species, reinforce this interpretation of a profile in which cash crops coexist with more directly food-oriented productions [23]. Studies on vanilla cultivation also provide insight into the logic of these tree-based systems, where the organization of support trees and associated species depends on the history of land use, thereby distinguishing these configurations from those centered primarily on subsistence crops [24]. Finally, the relatively central grouping of rice-related modalities in the multiple correspondence analysis is consistent with the importance of rice and tubers in rural diets, as well as with the constraints and trade-offs characteristic of rainfed rice systems, particularly in eastern Madagascar [25, 26].

4.1.2. Diversified crop–livestock system

In the multiple correspondence analysis (Figure 2), Class 2 is positioned closer to the central core of common practices, with a weaker association with perennial cash-crop modalities. Benchmarking distributes its contribution across several axes, with a strong presence of modalities related to food crops and basic livestock activities, whereas perennial cash crops contribute little to its characterization (Figure 4). This structure explains the statistical proximity between Classes 1 and 2 observed in the discriminant analysis and the transitions observed from Class 1 to Class 2: the two profiles share a food-crop base but differ in the relative weight of cash crops and in the role played by the livestock component. Reviews on the adoption of sustainable practices in sub-Saharan Africa help situate this profile: production systems tend to maintain certain established components, whereas the accumulation of new practices and specialization remain constrained by liquidity, access to advisory services, and land tenure security [7]. In the southern Ethiopian highlands, a typology of dairy systems in mixed farming also reveals a continuum between more diversified and more constrained profiles, with strong influence from access to resources and markets [14]. The presence of a poultry enterprise is also consistent with analyses of mixed crop–livestock systems in Madagascar, which highlight technical complementarities and the role of livestock integration in stabilizing crop production [27].

In the SAVA region of Madagascar, studies also show that the expansion of cash crops does not automatically lead to a strengthening of local livestock value chains, which may contribute to maintaining configurations where livestock activities are present but do not become a marker of specialization [23]. In addition, findings on food security during the lean season indicate that stabilization of household consumption often depends on market access and monetary income. This perspective helps explain the gap between a clearly identified "cash-crop pole" and a broader base of more common agricultural practices [28].

4.1.3. Low-diversification system

Class 3 stands out clearly in the multiple correspondence analysis on the side of withdrawal modalities, showing greater proximity to "no crop" modalities than the other profiles (Figure 2). Benchmarking associates this class with strong contributions from numerous absence modalities across both plant and livestock productions (Figure 5). As a result, the radar representation reflects a configuration driven by absences rather than by a core of active practices. This configuration does not correspond to a specialized perennial cash-crop system but rather to a reduced agricultural engagement, characterized by withdrawal from livestock activities and, for some households, the absence of declared crop production. Contraction of agricultural activity under shock conditions has also been documented in surveys of smallholders in Tanzania, where the combined effects of COVID-19 and climatic variability weakened market access and disrupted cropping systems [11].

In such contexts, research in southeastern Madagascar documents the use of wild food resources during the lean season when the productive base remains limited, highlighting the possible link between low productive engagement and alternative food procurement strategies [20]. Reviews of agroforestry cash-crop value chains further place this profile within a broader landscape where highly market-integrated systems coexist with more marginal productive configurations [17].

4.2. Identification of producers' needs

The PERT diagram (Figure 6) organizes producers' needs as dependency circuits derived from significant correlations. Three entry points structure the network: supplier, training, and agriculture. The arrows connect needs that tend to appear jointly in producers' statements, with solid lines representing positive associations and dashed lines representing negative associations.

4.2.1. Technical and financial needs

The "production" circuit begins with training and converges toward production/yield, which then redistributes toward operational needs such as canal infrastructure, increase in production, cattle/zebu, location/site, cooperative, entrepreneur/operator, and product prices. The sequence production, increase in production, equipment, and hoe leads to fertilizer, with a negative relationship, indicating that this input occupies a distinct position within the set of technical needs linked to equipment. This sequence reflects a need to strengthen productive capacity, promote the dissemination of applicable technical practices, and improve access to equipment and inputs, with an explicit expectation of solutions directly usable at farm level. This pattern supports an interpretation centered on productive leverage points and access to technical means, consistent with recent studies in Madagascar highlighting the importance of agricultural performance for household food outcomes [29].

The “household resources” circuit starts from agriculture and connects land to money, with a negative link between money and assistance. A second path, originating from supplier, connects sufficiency to household, then to implementation, livelihoods, and the marketing chain. The arrangement of these terms points to needs related to secure land access, availability of liquidity, and external support or resources, with a clear articulation between household management and economic integration. Together, these elements place liquidity constraints, household organization, and access to support resources at the same level of expression. This finding is consistent with studies linking market participation and non-farm income to improved household food security and greater dietary diversity among women compared with production diversity alone [28]. Similar observations appear in the dairy sector in West and East Africa, where the COVID-19 crisis disrupted supply chains, marketing opportunities, and farm liquidity in Burkina Faso, Kenya, and Senegal, reinforcing the centrality of financing and market needs [12].

4.2.2. Needs related to equipment, infrastructure, and climate risks

The circuit originating from household connects implementation to variability, then to climate and daily life, continuing toward coping strategies. Within the same sequence, implementation also points to drought. A second set, linked to the production pole, connects improvement to heat/temperature and cyclone. The sequence improvement – cyclone then leads to livestock farming. In addition, the segment including support and heavy rainfall, together with the negative association between work and flooding, explicitly integrates hydro-meteorological hazards into the structure of needs. These chains express needs related to anticipating and reducing exposure to climate shocks, as well as to organizing production activities and supporting the maintenance of production systems under adverse conditions. Reviews of climate-smart agriculture in sub-Saharan Africa describe similar constraints, including deficits in infrastructure, climate services, and financing, which limit the adoption of risk-reduction practices [3, 4].

These findings are consistent with evidence of strong seasonal food insecurity and vulnerability to weather shocks in several rural areas, which reinforce demand for infrastructure and support services [19]. They also align with results showing the importance of risk and time preferences in food-related decision-making, interacting with material constraints related to accessibility [26].

4.2.3. Food and market access needs

The circuit beginning with place leads to waiting time and reserved/dedicated. From waiting time, two axes emerge: one toward food and another toward seed. The food segment continues toward tools, then autonomy, and rain, with two outputs toward purchase and support. The food segment also connects to work, then legal compliance, which leads to ease or affordability and to food stocks or edible agricultural products. At the same time, the chain originating from climate leads to all year-round availability, then to purchase and rice, which branches toward trade, clove, cassava, and mechanical weeder. This circuit reflects needs related to food access, purchasing capacity, support during constrained periods, and the securing of consumable stocks, with continuity toward production and marketing choices. The association between livestock and food security documented in Vakinankaratra region of Madagascar further reinforces the relevance of the position occupied by livestock farming within this needs network [18]. In the Indian Ocean region, an analysis conducted in the Comoros shows that external shocks and trade disruptions rapidly affect food security, highlighting the importance of market outlets and price stabilization mechanisms [8].

Finally, the simultaneous presence of marketing chain, product prices, purchase, and sale places the commercial function at the center of these sequences. This observation is consistent with studies describing successful households as those combining productive practices with market integration adapted to local contexts, as well as with proposals for context-specific support based on local innovations [20, 30]. This configuration points to needs related to market access, transaction stabilization, price information, and support in meeting formal requirements, with a clear link to the commercial orientation of agricultural production.

5. Conclusion

This study provides two complementary findings that address the research questions raised for the eastern coast of Madagascar. First, the analysis of agricultural practices identifies clearly differentiated farm profiles. The typology is based on a clear statistical separation between classes, which reduces the risk of arbitrary classification. This result supports Hypothesis 1, namely that combinations of agricultural practices generate distinct farmer profiles. Second, the ordering of producers’ needs reveals a hierarchy based on the interdependence of expressed needs. The core of the network groups cross-cutting needs related to productive capacities and conditions of market access, whereas more specific needs occupy a peripheral position. This result also supports Hypothesis 2, namely that producers prioritize needs related to productive capacities and marketing conditions.

These conclusions remain consistent with the evidence produced. The typology derives from regularities observed in reported practices, and the ranking of needs derives from the structure of significant relationships. However, the study does not allow causal inference regarding the effects of profiles on economic or nutritional performance, because the design does not include longitudinal data or direct measures of impact. Future research could strengthen the operational scope of the approach. An explicit linkage between practice profiles and ordered needs would provide a more precise basis for targeting interventions. Extension to other regions, the integration of quantitative variables, and temporal validation would further improve the robustness and transferability of the findings.

Compliance with ethical standards

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Disclosure of Conflict of interest

The authors declare that they have no conflict of interest.

Statement of ethical approval

The study was conducted in accordance with standard ethical principles governing social research involving human participants.

Statement of informed consent

Oral informed consent was obtained from all individual participants included in the study before data collection.

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