World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Determinants of food security among women of reproductive age in Masindray, Madagascar

Tsanta Herilova RAKOTONIRINA [1, *], Romaine RAMANANARIVO [2], Sylvain RAMANANARIVO [2], Jules RAZAFIARIJAONA [2], Jules RAFALIMANANTSOA [3] and Andrianjanahary RAMAROMANANA [1]

[1] *Doctoral School of Natural Resource Management and Development (ED-GRND), Host team: Agro-Management and Sustainable Development of Territories (AM2DT), University of Antananarivo, Antananarivo, Madagascar.*
[2] *ED-GRND, Host team: AM2DT, University of Antananarivo, Antananarivo, Madagascar.*
[3] *Madagascar's National Nutrition Office (ONN), Antananarivo, Madagascar.*

World Journal of Advanced Research and Reviews, 2026, 29(03), 924-935

Publication history: Received on 05 February 2026; revised on 12 March 2026; accepted on 14 March 2026

Article DOI: https://doi.org/10.30574/wjarr.2026.29.3.0647

Abstract

In Madagascar, food security among women of reproductive age remains a major public concern. Assessments vary depending on the indicators used, making it more difficult to identify effective entry points for action. This study examined the determinants of food security among women of reproductive age in Masindray. It aimed to characterize food-security levels through a multi-indicator assessment and respondents' perceptions, and to identify the factors associated with these levels. The study used a cross-sectional quantitative survey of 396 women aged 15-49 years. It combined a multi-indicator diagnosis, an analysis of perceptions, and the identification of socioeconomic determinants associated with food security levels. Hierarchical cluster analysis (HCA), refined by discriminant factor analysis (DFA), generated three profiles using the Household Food Insecurity Access Scale (HFIAS), the Livelihood Coping Strategies Index (LCS), the Food Consumption Score (FCS), the Minimum Dietary Diversity for Women (MDD-W), and lean-season duration. A discourse analysis then informed a Program Evaluation and Review Technique (PERT) network, while benchmarking linked the profiles to 25 qualitative variables. The results show non-convergence across measures: anthropometric status and coping strategies often appear favorable, whereas the Minimum Dietary Diversity for Women (MDD-W) frequently indicates insufficient dietary diversity. The typology identifies an intermediate profile (58%), a food-insecure profile (35%), and a favorable profile (7%). Differences between profiles reflect combinations of access costs, domestic constraints, water access, human capital, and decision-making latitude. These findings support the value of a multi-indicator approach.

Keywords: Dietary diversity; Seasonal vulnerability; Household trade-offs; Access to services; Human capital

1. Introduction

In Madagascar, food security and nutrition remain major public concerns, with marked disparities among women of reproductive age. The lean season and price shocks affect food access, while access to productive resources and transaction costs shape both purchasing power and the ability to seek care [1]. The focus on women of reproductive age reflects their high nutritional requirements and their exposure to multiple forms of malnutrition. Intra-household trade-offs and control over resources also influence consumption patterns [2].

Everyday material conditions also matter. Access to water, domestic energy, food preservation facilities, and services influences hygiene, morbidity, and the ability to stabilize dietary practices. This perspective is consistent with food systems and resilience approaches, which link access, assets, and local vulnerabilities [3]. In Madagascar, several studies

* Corresponding author: Tsanta Herilova RAKOTONIRINA

also highlight the importance of assets and income, land access, market accessibility, and seasonality in shaping food-related vulnerabilities [4].

A methodological issue further complicates the analysis. Assessments vary depending on the families of indicators used, because these instruments capture different dimensions and respond over different time horizons. Multi-indicator comparisons often produce non-overlapping interpretations for the same population [5]. For women, the literature also shows that dietary diversity is shaped by specific constraints and cannot be inferred from a single indicator of food access or coping strategies [6].

In this context, identifying the factors associated with women's food security requires an analysis that takes into account both the plurality of measures and local socioeconomic conditions. The present study therefore examines the situation observed in Masindray. Its objective is to characterize the levels of food security among women of reproductive age through a multi-indicator approach and to identify the factors associated with these levels.

The study addresses the following research question: which determinants explain the levels of food security among women of reproductive age in Masindray? Two sub-questions structure the analysis: what levels characterize food security among women of reproductive age in Masindray, and what factors determine these levels? Two hypotheses guide the study: first, that food security indicators distinguish different levels of food security; and second, that socioeconomic characteristics explain the food security levels of women of reproductive age.

2. Material and methods

2.1. Study area and sample

This study was conducted in the rural municipality of Masindray, located in the district of Antananarivo Avaradrano, Analamanga Region, Madagascar (18° 58′ 13.06″ S; 47° 37′ 41.24″ E). The area presents contrasting access conditions, particularly to markets, services, and mobility, making it a relevant setting for analyzing the food situations of women of reproductive age. A cross-sectional survey design was adopted. Data were collected between May and July 2025. The target population consisted of women of reproductive age (15–49 years) residing in the study area. Respondents were allocated across fokontany, the smallest local administrative units, in proportion to their demographic weight. In each fokontany, households were visited along a predefined route, and one eligible woman of reproductive age was interviewed per selected household until the target number of respondents was obtained. The survey therefore followed a quota-based sampling approach.

The required sample size was calculated using the standard formula for estimating a proportion:

$$n = \frac{z^2 \hat{P} \left(1 - \hat{P}\right)}{e^2}$$

where

- z is the standard normal deviate corresponding to the desired confidence level (1.96 for 95% confidence),
- p is the expected proportion (0.5),
- and e is the margin of error (0.05).

After adjustment for anticipated non-response, a total of 400 women were surveyed. Four questionnaires were incomplete and were excluded, leaving 396 completed questionnaires for analysis. Participation was voluntary.

2.2. Description of food security indicators

Each indicator was recoded into four ordered qualitative levels (Table 1). These levels were derived from the standardized classifications specific to each indicator. They were then harmonized onto a common scale ranging from the least favorable (level 1) to the most favorable (level 4). The harmonization into four ordered levels did not imply a strictly symmetrical recoding across indicators. Recoding was based on the substantive interpretation of each indicator's threshold categories and their relative position along a least favorable to most favorable continuum. For some indicators, no category corresponded to one of the intermediate levels. The distribution of respondents was finally expressed as percentages and presented as stacked bar charts.

The indicators included body mass index (BMI), mid-upper arm circumference (MUAC), the reduced Coping Strategies Index (rCSI), the Household Food Insecurity Access Scale (HFIAS), the Livelihood Coping Strategies Index (LCS), the Food Consumption Score (FCS), and the Minimum Dietary Diversity for Women (MDD-W).

Table 1 Recoding of food security indicators into levels 1 to 4

Indicator	Category	Recoded level
BMI	Undernutrition < 18.5	Level 1
	Normal 18.5–24.9	Level 4
	Overweight 25–29.9	Level 3
MUAC	Acute undernutrition < 210	Level 1
	At risk 210–229	Level 2
	Normal ≥ 230	Level 3
HFIAS	Food secure	Level 4
	Mild food insecurity	Level 3
	Moderate food insecurity	Level 2
	Severe food insecurity	Level 1
LCS	No coping strategy	Level 4
	Stress	Level 2
	Crisis	Level 1
	Emergency	Level 1
rCSI	Low	Level 4
	Medium	Level 2
	High	Level 1
FCS	Poor 0–21	Level 1
	Borderline 21.5–35	Level 2
	Acceptable > 35	Level 4
MDD-W	Not achieved	Level 1
	Achieved	Level 4
Lean season duration	None	Level 4
	Short 1-2 months	Level 3
	Medium 3-4 months	Level 2
	Long > 4 months	Level 1

2.3. Ranking of determinant factors based on women's perceptions

Determinant factors based on women's perceptions were identified through discourse analysis. Each respondent's answers were treated as documents, after which segmentation was used to extract a vocabulary of terms. A frequency matrix was then constructed, followed by a term-correlation matrix computed in XLSTAT. The significance of an observed correlation rij was assessed at the α = 0.05 level using a critical threshold rc 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 $t_{1-\alpha/2,\ n-2}$ the Student's t quantile with n − 2 degrees of freedom. A binary matrix B was then constructed, with Bij = 1 if |rij| > rc, and Bij = 0 otherwise.

The ranking of variables was performed in Excel. For each variable j, the degree of significant connection within the network was defined as Sj = $\sum_i$ Bij. At each iteration, the variable with the lowest Sj was removed, and the matrix was then updated by deleting the corresponding row and column, until all variables had been exhausted. The elimination order provided an inverse ranking: the first variables removed were the least connected, whereas the last were the most interdependent, thereby yielding an interpretable hierarchy of determinants.

For the analysis, the list used was already reversed: Rank 1 grouped the variables with the highest number of significant correlations, and connectivity then decreased with increasing rank order. Based on the ordered list of variables and the binary matrix B, a Program Evaluation and Review Technique (PERT) diagram was constructed. It was used here as a graphical structuring tool to display hierarchical interdependencies among terms derived from respondents' perceptions. For each term, the diagram retained a single incoming link from a more connected term, selected according to the highest absolute intensity; the sign of the correlation determined whether the line was continuous or dashed.

2.4. Construction of food security profiles and determinant factors

The typology was based on the HFIAS, LCS, FCS, MDD-W, and lean season duration. Hierarchical cluster analysis (HCA) produced three classes, and discriminant factor analysis (DFA) was then used to verify profile separation.

The empirical profiles obtained were used as the grouping variable for a benchmarking DFA. The DFA mobilized 84 qualitative variables distributed across 18 domains: land access, access to services, preservation and hygiene, food choice criteria, demographic data, drinking water, savings and decision-making, shortage management, education level, assets and finances, food preferences and constraints, animal products and livestock, nutrition awareness, energy sources, cropping system, time use and domestic workload, and other socioeconomic characteristics.

The benchmarking procedure used all qualitative variables and their categories, with a one-dimensional examination based on tests derived from DFA. An additional significance-based selection reduced the representation of variables to a core set of 25 categories. This selection was based on the highest inter-profile contrasts, identified through extreme values, using the maximum and minimum values observed across profiles for each category. In the legend, the category most characteristic of a profile is indicated in green and the least characteristic in red.

3. Results

3.1. Food security levels

After harmonizing each indicator into four ordered levels, from the least favorable to the most favorable, the distribution of observations was presented as stacked bar charts (Figure 1). The anthropometric indicators and coping measures were concentrated mainly in the favorable levels, whereas the Minimum Dietary Diversity for Women (MDD-W) more often indicated that minimum dietary diversity had not been achieved. Lean season duration was distributed across levels 1 to 3 (Figure 1).

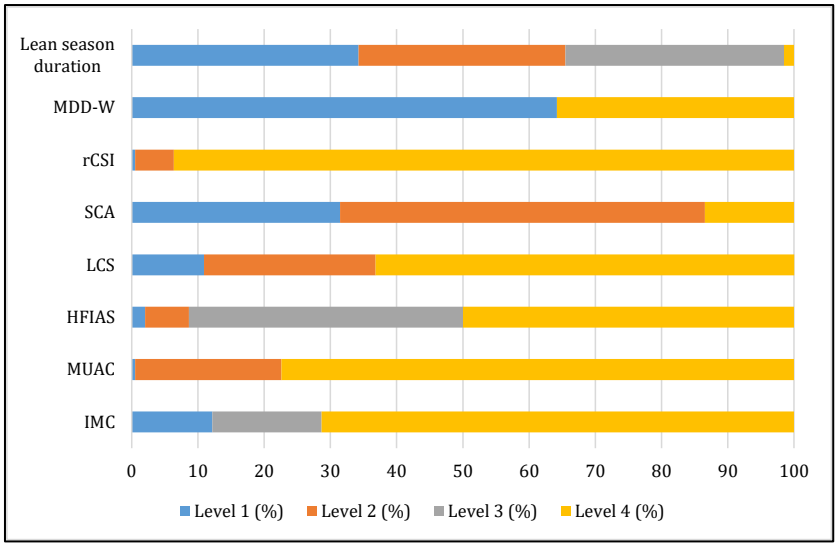

Figure 1 Distribution of food security indicators across recoded levels 1 to 4 among women of reproductive age

3.2. Women's perceptions of food security determinants

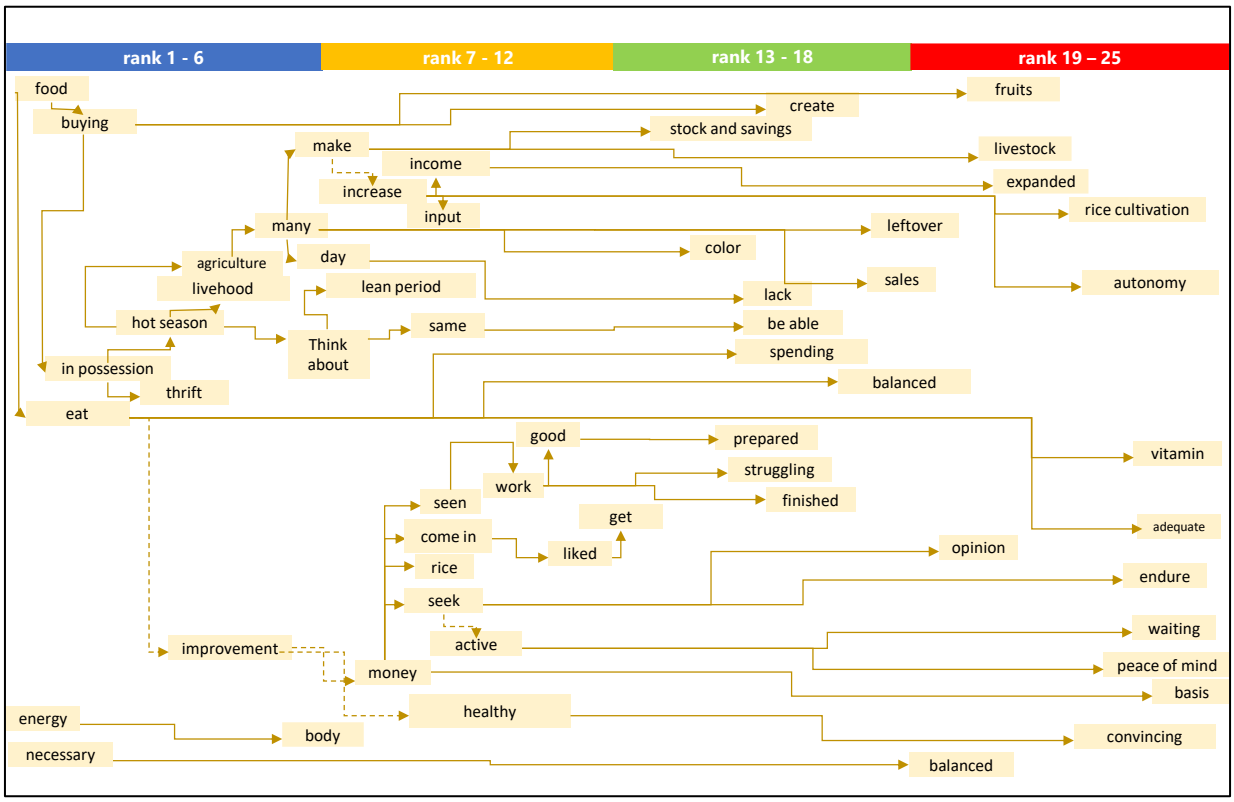

Figure 2 PERT network of determinant factors based on women's perceptions

The ranking procedure produced a hierarchy of connectivity between lexical units, which was used to construct a Program Evaluation and Review Technique (PERT) network. The diagram preserves rank order and, for each target term, retains the significant correlation with the greatest absolute value from a term at a higher connectivity level (Figure 2).

Three entry points structured the network: "food," "necessity," and "energy." The circuit associated with "food" followed two main branches, "buying" and "eating." The "buying" branch passed through the nodes "in possession" and "hot season," then extended toward "agriculture" and "many." From "many," one chain led to "color," while another connected to "make," "leftover," and "sales." The node "make" was negatively linked to "increase" (dashed line) and also

connected to “stock and savings” and “livestock.” The node “buying” was further linked to “create” and “fruits.” The “eating” branch connected “make” and “spending,” and a dashed link connected “eating” to “improvement,” with two additional dashed outputs toward “money” and the “healthy” dimension. From “money,” the network extended toward “seen,” “come in,” and “seek,” then toward “active” through a dashed link and toward “peace of mind.” The circuit associated with “energy” connected to the “body,” whereas the determinant linked to “necessity” was connected to “balanced.”

3.3. Typology and determinant factors of food security

3.3.1. Typology

HCA, subsequently refined by DFA, distinguished three classes: an intermediate profile (Profile 1), a food-insecure profile (Profile 2), and a food-secure profile (Profile 3).

- Profile 1 (intermediate profile, 58%): it showed two peaks for the HFIAS and lean season duration. The FCS and LCS remained secondary, while MDD-W was located at the lowest level.
- Profile 2 (food insecurity profile, 35%): it was located at the lowest level across all food security indicators.
- Profile 3 (food security profile, 7%): it showed high values across all indicators, with dominant levels for LCS, MDD-W, and FCS, followed by high values for HFIAS and lean season duration.

3.3.2. Determinant factors

DFA based on the 84 qualitative variables confirmed overall differences between profiles, with Wilks’ lambda = 0.1205 and $p < 0.0001$. In total, 74 categories were significant; the presentation focuses on a core set of 25 categories with high contrasts (Figures 3 to 5).

Profile 1 was mainly associated with land rental (V4) and lower mobility (V55), together with a longer lean season and more frequent failure to achieve minimum dietary diversity among women (Figure 3). Profile 2 combined formal land rights (V1) with low perceived land security (V6), more precarious water access (V22), a low contribution from livestock (V32), and agricultural sales decisions controlled by the spouse or father (V38), together with lower educational capital (V69, V73) (Figure 4). Profile 3 was associated with safer water access (V21, V23), longer food preservation (V18), mobility (V55), and greater budget flexibility (V58), along with higher income and education levels (V60–V63, V68, V71) (Figure 5).

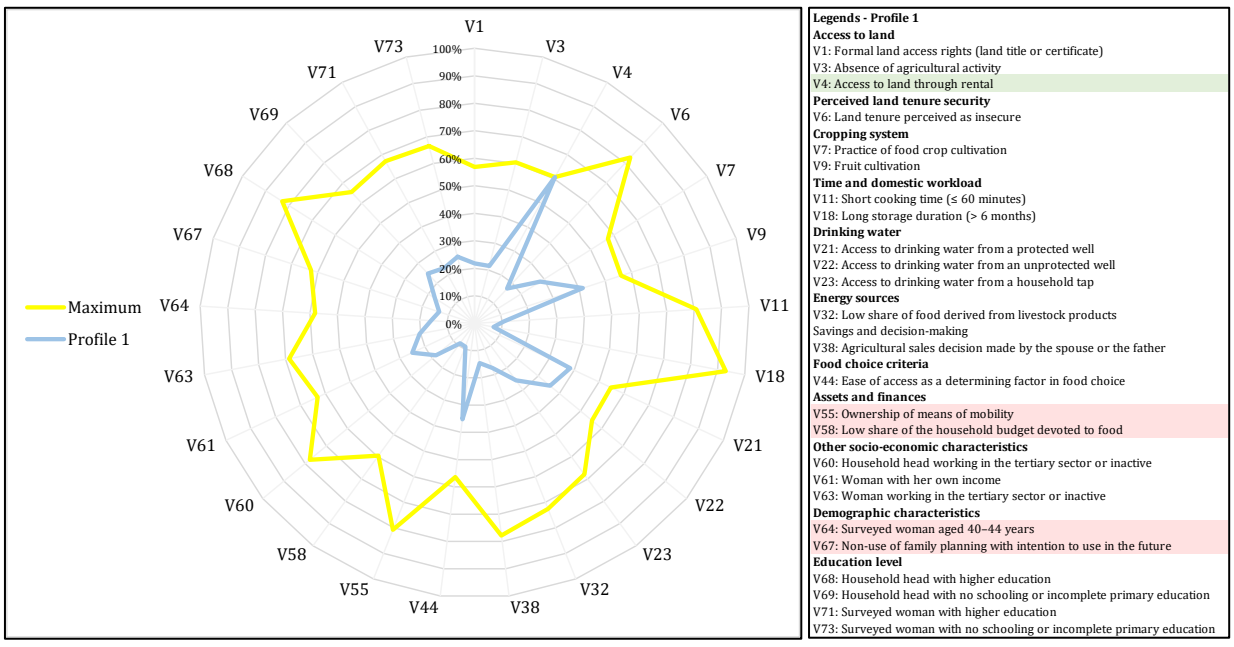

Figure 3 Determinant factors of food security - Profile 1: Intermediate profile

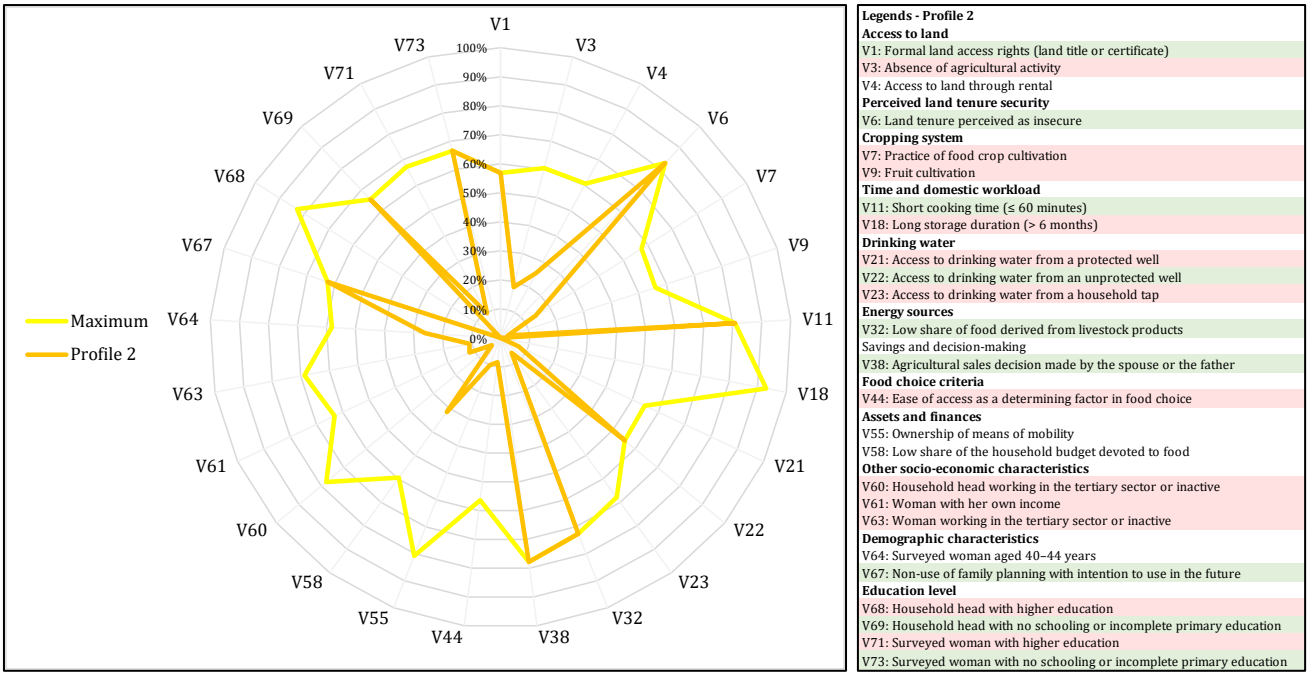

Figure 4 Determinant factors of food security - Profile 2: Food insecurity profile

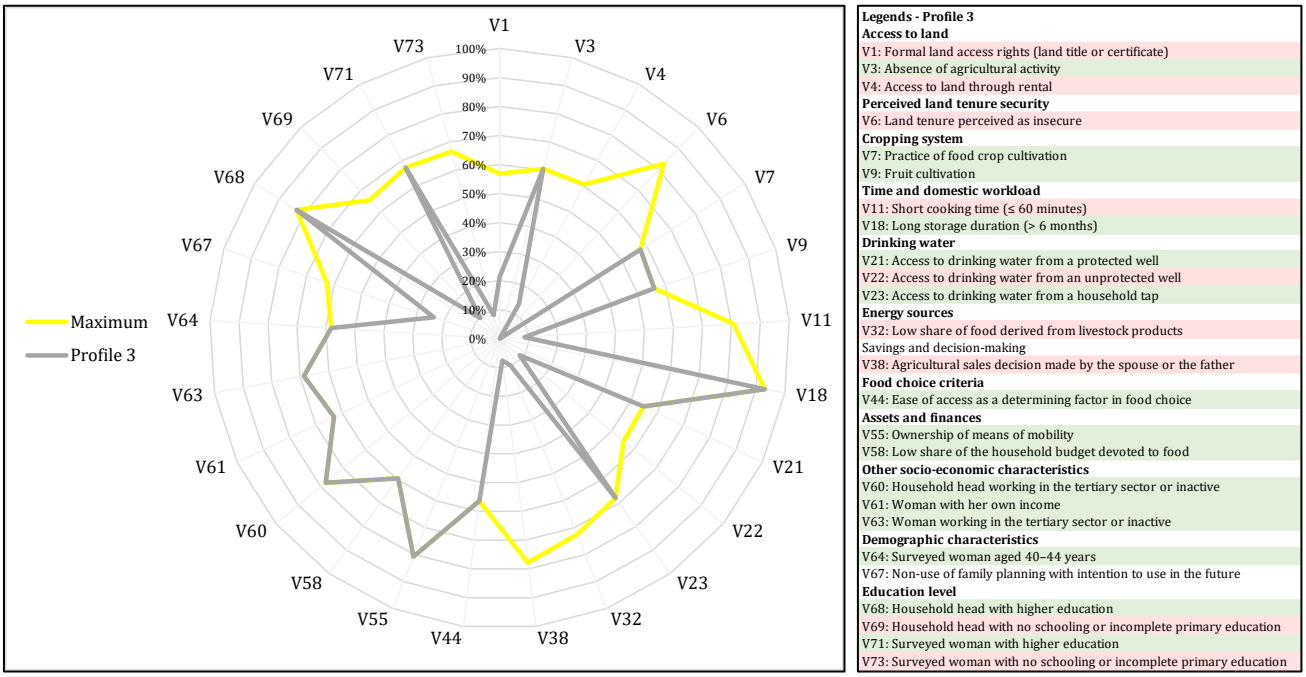

Figure 5 Determinant factors of food security - Profile 3: Food security profile

4. Discussion

4.1. Indicators and levels of food security

The recoding into levels 1 to 4 produces an initial contrast: anthropometric indicators and coping measures (LCS, rCSI) place most women in the most favorable levels, whereas the Household Food Insecurity Access Scale (HFIAS) and, above all, the Minimum Dietary Diversity for Women (MDD-W) reveal a larger share of constrained situations. This finding confirms that “security” depends on the point of observation: the absence of acute anthropometric deterioration and

the limited use of severe coping strategies do not guarantee either sufficient dietary diversity or a favorable perception of deprivation.

Two mechanisms may explain this apparent dissociation. The first relates to the priority given to staple foods: the basic ration is more easily maintained, which supports body mass index (BMI) and mid-upper arm circumference (MUAC), whereas dietary diversity deteriorates rapidly when prices increase or cash flow tightens. The second relates to adjustment margins: limited coping may reflect lower pressure, but it may also indicate that the options for activating coping strategies are already constrained, leaving the household "locked" into a monotonous diet. Studies conducted in contexts comparable to Madagascar and Burkina Faso describe this type of dissociation and emphasize that coping strategies document a response rather than nutritional status [7]. Here, MDD-W acts as an indicator of dietary quality: women's dietary diversity varies with access to non-staple foods, control over resources, and intra-household trade-offs. This sensitivity is consistent with studies conducted in Madagascar linking dietary diversity to resource control and the health environment, with marked gradients across social groups [8].

Multi-indicator readings often lead to partially discordant classifications, depending on the recall window and the classification rule used. This finding supports a cautious interpretation of levels and the analytical use of profiles, especially under strong seasonality and coping constraints [9, 10].

4.2. Perceived determinants of food security

4.2.1. Food and economic access

The food circuit unfolds along two branches, buying and eating. The buying branch connects in possession, hot season, agriculture, and then many, with extensions toward sales, stock and savings, livestock, and fruits. This sequence places monetary access and livelihoods at the forefront. In the discourse, the act of buying links with a portfolio of activities and assets. This structure is consistent with the livelihoods framework. It also corresponds to analyses that distinguish availability, access, and utilization as separate sources of vulnerability. The HLPE framework identifies access and stability as distinct dimensions in their own right [1].

4.2.2. Seasonality, production, and adjustment strategies

The presence of the hot season, followed by livelihood, indicates seasonal tension followed by practical responses. The many block connects to make, leftover, and sales, which reflects trade-offs between stocks, consumption, and market transactions. The negative link between make and increase suggests a perception of constraint. Greater effort does not necessarily correspond to perceived improvement. The resilience literature interprets these adjustments as constrained responses rather than as a direct pathway out of insecurity [11].

4.2.3. Consumption, health, and mental burden

The eating branch connects make and spending. A negative link connects eating to improvement, then to money and the healthy dimension. The network expresses tension. The search for better food relates to financial and health constraints rather than to simple preference. This articulation corresponds with right-to-food frameworks that require both economic accessibility and nutritional adequacy. From money, the chain seen – come in – seek leads to active through a negative link and to peace of mind. The discourse therefore links income with continuous searching and mental burden. Studies on food crises and food-security information systems show that numerical indicators do not capture these lived dimensions [12, 13].

4.2.4. Balance, bodily energy, and links with standardized measures

The node necessity connects to balanced, and energy connects to the body. These associations anchor food security in concrete nutritional references such as dietary balance and physical capacity. They correspond with frameworks linking food security, nutrition, and the food environment [14]. The relevance is strong for women of reproductive age. Methodologically, interpretation of lexical chains becomes stronger when integrated into triangulation with empirical profiles and standardized indicators. Construct validity then relies on partial convergence while leaving room for interpretable divergences [15]. Indicator comparisons also show that each measure captures a specific facet of insecurity. The perception network provides a complementary entry point centered on language and stated priorities.

4.3. Empirical profiles and determinants of food security

4.3.1. Three profiles and their dominant vulnerabilities

Profile 1 combines a less favorable lived experience (HFIAS) and a longer lean season with lower female dietary diversity (MDD-W). This profile suggests strongly seasonal vulnerability: pressure on availability and prices increases perceived insecurity and first reduces dietary quality, while meal volume may remain more stable because of staple foods. Two mechanisms appear plausible: a trade-off that preserves quantity at the expense of variety, followed by a cash-flow constraint that limits the purchase of non-staple foods during the lean season. Profile 2 lies closer to the factorial center and accumulates less favorable values across all dimensions, without a marked break on a single indicator. This configuration points to diffuse vulnerability: limited endowments, reduced adjustment margins, and the accumulation of modest deficits, bringing the situation closer to a chronic constraint than to an identifiable seasonal episode. Profile 3 groups the most favorable values for consumption (FCS), dietary diversity (MDD-W), and LCS, followed by HFIAS and lean season duration. The small size of this group (n = 26) indicates that such conditions remain uncommon; this profile mainly serves as an analytical benchmark for identifying a set of conditions compatible with more favorable outcomes.

The observed profiles confirm partial overlap among lived experience, coping, consumption, and dietary diversity. The typology therefore helps describe configurations rather than a single order of "security" [16]. At the same time, a multi-country study shows that typologies remain sensitive to the choice of components and to multiple grouping rules, which supports using profiles analytically rather than treating them as fixed entities [10].

4.3.2. Determinants of food security

Productive base, security of access, and diversification potential

Land-related variables describe the productive base and room for maneuver. Profile 2 is associated with formal land rights (V1) while more often reporting low perceived land security (V6), pointing to uncertainty that may reduce investment and planning. Profile 1 is more closely associated with rental arrangements (V4), which increases the reversibility of access and exposure to shocks. The literature on land and food security reports links through production, income, and own consumption, with heterogeneous effects depending on investment capacity, market integration, and price volatility in Nigeria [17].

Profile 3 is more often associated with the absence of agricultural activity (V3) and with a combination of assets, mobility, and human capital (V55, V68, V71), consistent with stronger integration outside agriculture. Food crops and fruit crops (V7, V9) may broaden availability, subject to intra-household trade-offs. The literature on income diversification supports this interpretation: protection rarely rests on a single pillar, but rather on a combination of income, assets, and access [18, 19].

Studies conducted in Mali also confirm a frequent association between production diversity and consumption diversity, mediated by control over resources and decision-making within the household [20]. In the Malagasy context, dietary quality remains sensitive to the combination of income, livestock, and access, including among specialized producers [21].

Daily constraints

Short cooking time (V11) is associated with Profile 2 and may indicate meal simplification, especially when access to dietary diversity remains costly. Qualitative approaches in Europe describe a reorganization of routines under stress, with a narrowing of the meal repertoire [22].

Water access also differentiates the profiles: Profile 2 is associated with unprotected wells (V22), whereas Profile 3 is more closely associated with safer sources (V21, V23), reflecting the water-hygiene-morbidity nexus. Recent work in Toliara on parasites and anemia strengthens the idea of a link between health constraints and nutritional vulnerabilities [23]. Long preservation duration (V18) characterizes Profile 3 and may support greater stability under seasonal conditions.

Transaction costs and effective access to services

Within the core set, mobility is a clear marker of differentiation, with overrepresentation in Profile 3 (V55). Mobility reduces transaction costs, facilitates smaller and more frequent purchases, and supports access to care. Low mobility makes trade-offs more rigid, especially under cash-flow and time constraints. Empirical reviews on market access

frequently report a positive association between access and dietary diversity, through mechanisms that vary according to relative prices, local supply, and income [24]. This point reinforces the idea that an isolated asset rarely explains the typology; combinations are what matter.

Animal products, the role of livestock, and dietary quality

Variables related to animal products condense purchasing power, access, norms, and availability. The core set retains a low share of food derived from livestock, strongly associated with Profile 2 (V32). This category suggests more indirect access to animal products, more exposed to price effects, and it combines with other vulnerabilities that also appear in the core set for Profile 2, particularly exposed water access, lower educational capital, and decision constraints (V22, V69, V73, V38). This pattern is consistent with broader evidence that dietary diversity depends on access to diverse food sources [21, 25].

Intra-household decision-making, preferences, and shortage management (V34–V53)

Agricultural sales decisions controlled by the spouse or father (V38) characterize Profile 2 and suggest more limited decision-making latitude for women, with a risk of weaker protection of women's diets under constraint. Choice criteria and preferences also confirm access-related trade-offs: ease of access (V44) is more strongly associated with Profile 3 (Figure 5), whereas Profiles 1 and 2 more often express tension between the aspiration to diversify and actual access. Responses regarding shortages also evoke prioritization of children, at the cost of restriction among adults. This logic echoes work on coping strategies and the gradual erosion of capacities [26].

Assets, food budget, income, and human capital

Profile 3 is associated with higher mobility (V55), a lower share of the budget devoted to food (V58), and more favorable signals of income and human capital (V60–V63, V68, V71). The literature confirms associations between diversification, own income, and food protection, mediated by agency, in Uganda as well as in multi-country comparisons [27, 19]. Profile 2 is associated with lower education levels (V69, V73) and a more constrained family trajectory (V67), which may reinforce vulnerability when access and assets remain limited. The literature links education, income diversification, and food security through access to employment, information, and service use in Ethiopia [18, 28].

5. Conclusion

This study examined food security among women of reproductive age in Masindray using a multi-indicator approach combined with an analysis of perceived determinants. The results show that food security indicators capture different dimensions and time horizons of food insecurity, which explains the lack of convergence toward a single diagnostic and supports the relevance of a multi-indicator interpretation. The typology identified three distinct profiles: an intermediate profile, a food-insecure profile marked by stronger and more seasonal constraints, and a food-secure profile associated with more favorable conditions. These profiles correspond to specific combinations of socioeconomic conditions, including access to markets and services, household-level constraints, economic resources, and intra-household decision-making margins. The analysis of perceptions complemented these findings by highlighting a network of determinants organized around food, necessity, and energy, showing how access to food is closely linked to livelihood strategies, seasonal constraints, and daily living conditions.

Future research could examine the stability of these profiles across seasons and compare different rules for aggregating food security indicators in order to better understand the conditions under which different indicators converge or diverge. By improving the understanding of how socioeconomic conditions and local constraints shape women's food security, this study provides evidence that can support more targeted policies and future research aimed at strengthening nutritional resilience in vulnerable populations.

Compliance with ethical standards

Acknowledgements

The authors gratefully acknowledge the contribution of the community nutrition agents in the study area, who facilitated field access and supported survey organization during data collection.

Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

Statement of ethical approval

The study involved a questionnaire-based survey conducted among women of reproductive age in the study area. Prior to data collection, verbal authorization for the conduct of the survey was obtained from the relevant local authorities. The study followed standard ethical principles for social research involving human participants.

Statement of informed consent

Participation was voluntary. The purpose of the study was explained to each participant before the interview, and informed consent was obtained before questionnaire administration.

References

[1] HLPE. Food security and nutrition: building a global narrative towards 2030. Rome: High Level Panel of Experts on Food Security and Nutrition, Committee on World Food Security; 2020. 113 p.

[2] Njuki J, Eissler S, Malapit H, Meinzen-Dick R, Bryan E, Quisumbing A. A review of evidence on gender equality, women's empowerment, and food systems. In: von Braun J, Afsana K, Fresco LO, Hassan MHA, eds. Science and innovations for food systems transformation. Cham: Springer; 2023. p. 165-189.

[3] FAO, IFAD, WHO, WFP. The state of food security and nutrition in the world 2022: repurposing food and agricultural policies to make healthy diets more affordable. Rome: FAO; 2022. 260 p.

[4] Rousseau S, Steinke J, Vincent M, Andriatseheno H, Pontarollo J. Strong seasonality in diets and alarming levels of food insecurity and child malnutrition in south-eastern Madagascar. Front Sustain Food Syst. 2023;7:1126053.

[5] IPC Global Partners. Integrated Food Security Phase Classification technical manual version 3.1: evidence and standards for better food security and nutrition decisions [Internet]. Rome: IPC Global Partners; 2021 [cited 2026 Feb 18]. Available from: https://www.ipcinfo.org/fileadmin/user_upload/ipcinfo/manual/IPC_Technical_Manual_3_Final.pdf

[6] Mekonen H, Endalifer ML, Assaye BT. Maternal dietary diversity increases with women's high decision-making autonomy in Northwest Ethiopia, 2022. Heliyon. 2024;10(11):e31735.

[7] Ngoutane RM, Murray-Kolb LE, Zoma R, Ouédraogo CT, van Zutphen KG, Bruning R, et al. A comparative analysis of maternal nutrition decision-making autonomy during pregnancy: an application of the Food Choice Process Model in Burkina Faso and Madagascar. Food Nutr Bull. 2024;45(1):47-56.

[8] Rotella R, Soriano JM, Peraita-Costa I, Llopis-González A, Morales-Suarez-Varela M. Evaluation of nutritional status using the minimum dietary diversity for women of reproductive age (MDD-W) tool in breastfeeding mothers in Madagascar. Trop Med Int Health. 2024;29(7):622-632.

[9] Drimie S, Korpi K, Falkowitz O, Wagner A, Tiba Z, Armstrong J. Developing a livelihood change indicator for the Integrated Food Security Phase Classification system. Luxembourg: European Commission, Joint Research Centre; 2025. Technical Report EUR 40295. 58 p.

[10] Hanley-Cook GT, Gie SM, Parraguez JP, Holmes BA. Minimum dietary diversity for women: precision of national surveys and accuracy of brief data collection instruments. BMC Nutr. 2025;11(1):104.

[11] Béné C. Resilience of local food systems and links to food security: a review of some important concepts in the context of COVID-19 and other shocks. Food Secur. 2020;12:805-822.

[12] Enten F. Famines and "poor numbers". J Humanit Aff. 2023;5(1):37-51.

[13] Enten F. L'IPC à l'épreuve du kéré. Rev Int Etudes Dev. 2022;248:125-153.

[14] HLPE. Nutrition and food systems. Rome: High Level Panel of Experts on Food Security and Nutrition, Committee on World Food Security; 2017. 152 p.

[15] Cronbach LJ, Meehl PE. Construct validity in psychological tests. Psychol Bull. 1955;52:281-302.

[16] Jordan I, Röhlig A, Glas MG, Waswa LM, Mugisha J, Krawinkel MB, et al. Dietary diversity of women across agricultural seasons in the Kapchorwa District, Uganda: results from a cohort study. Foods. 2022;11(3):344.

[17] Kehinde M, Shittu A, Adewuyi S, Osunsina I, Adeyonu A. Land tenure and property rights, and household food security among rice farmers in Northern Nigeria. Heliyon. 2021;7:e06110.

[18] Bakhtsiyarava M, Williams TG, Verdin A, Guikema SD. A nonparametric analysis of household-level food insecurity and its determinant factors: exploratory study in Ethiopia and Nigeria. Food Secur. 2021;13:55-70.

[19] Carducci B, Benedict R, Corrigan J, Mayala B, Namaste S, Bilotto F, et al. Exploring women's dietary diversity amidst climate variability: a comparative analysis across eight low- and middle-income countries. Environ Res Lett. 2025;20:adf128.

[20] Adubra L, Savy M, Fortin S, Kameli Y, Kodjo NE, Fainke K, et al. The minimum dietary diversity for women of reproductive age (MDD-W) indicator is related to household food insecurity and farm production diversity: evidence from rural Mali. Curr Dev Nutr. 2019;3:nzz002.

[21] Andriamparany JN, Hänke H, Schlecht E. Food security and food quality among vanilla farmers in Madagascar: the role of contract farming and livestock keeping. Food Secur. 2021;13:981-1012.

[22] Bell Z, Scott S, Visram S, Rankin J, Bambra C, Heslehurst N. Experiences and perceptions of nutritional health and wellbeing amongst food insecure women in Europe: a qualitative meta-ethnography. Soc Sci Med. 2022;311:115313.

[23] Alfano MV, Gozalbo M, Tapia-Veloz G, Guirao V, Soriano JM, Trelis M. Nutrimetry and evaluation of intestinal parasites and anaemia in malnourished schoolchildren from Toliara (Madagascar). Children. 2025;12:225.

[24] Nandi R, Swamikannu N, Ravula P. The interplay between food market access and farm household dietary diversity in low- and middle-income countries: a systematic review of literature. Glob Food Secur. 2021;28:100484.

[25] Iannotti L, Randrianarivony T, Randrianasolo A, Rakotoarivony F, Andriamihajarivo T, LaBrier M, et al. Wild foods are positively associated with diet diversity and child growth in a protected forest area of Madagascar. Curr Dev Nutr. 2024;8(4):102101.

[26] Béné C, Headey D, Haddad L, von Grebmer K. Is resilience a useful concept in the context of food security and nutrition programmes? Some conceptual and practical considerations. Food Secur. 2016;8:123-138.

[27] Barak F, Efitre J, Odong R, Melgar-Quiñonez H. Women's agency in nutrition in the association between women's empowerment in agriculture and food security: a case study from Uganda. World Food Policy. 2023;9:228-249.

[28] Etea TD, Yalew AW, Sisay MM. Mediating effects of women's empowerment on dietary diversity during pregnancy in Central West Ethiopia: a structural equation modelling. Glob Health Action. 2023;16(1):2290303.