

Assessing Farmers' Diverse Preferences and Expectations for Tailoring Food and Nutrition Security Interventions in Southeastern Madagascar

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ABSTRACT

Background: Severe food and nutrition insecurity persists in Madagascar. The Atsimo Atsinanana region is among the most affected areas due to elevated poverty rates and low levels of resilience to frequent shocks. Implementing food and nutrition security (FNS) interventions could help to improve this situation, but to be effective and sustainable, intervention packages must fit the local context.

Objectives: To identify locally suitable options, this study assessed the perceptions of local communities in rural Atsimo Atsinanana toward a range of FNS intervention options.

Methods: We held 12 gender-disaggregated workshops with 80 prospective beneficiaries of an FNS project, from inland and coastal parts of the region. Preferences were elicited for 14 potential FNS interventions. Next, through participatory ex ante impact assessment, participants ranked 8 impact criteria and individually estimated expected impacts of all intervention options on these criteria.

Results: Overall, participants preferred interventions targeting on-farm crop, vegetable, and livestock production. Income and food self-sufficiency were ranked as the highest intervention priorities. However, intervention preferences differed by gender and geographic location. Whereas preferences for interventions targeting dietary habits were weak across genders, women had relatively stronger preferences for these interventions than men. This shows that collecting gender-disaggregated preferences can enable more gender-sensitive choice of interventions. Preferences also reflected local livelihoods, as more market-oriented coastal sites showed stronger interest in income generation than more subsistence-oriented inland sites. The ex ante impact assessments highlight positive and negative expectations for most interventions, with increased labor burden being the most prominent negative impact overall.

Conclusions: The findings suggest that participatory, multidimensional impact assessments before project implementation can support development stakeholders in tailoring intervention packages, considering 1) local and gendered preferences and 2) trade-offs among development objectives. *Curr Dev Nutr* 2022;6:nzac142.

Keywords: Atsimo Atsinanana, criteria ranking, ex ante impact assessment, food security, smallholder farmers

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Abbreviations used: DRAEP, Direction Régionale de l'Agriculture, l'Élevage et de la Pêche (Regional Direction of Agriculture, Livestock, and Fisheries); FNS, food and nutrition security; GIZ, Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation); SWOT, strengths, weaknesses, opportunities, threats; WASH, water, sanitation, and hygiene.

Introduction

Madagascar experiences high levels of acute and chronic food insecurity, in part due to the vulnerability of farming and rural livelihoods to recurring droughts and cyclones (1–4). Globally, Madagascar presents some of the most alarming numbers on food and nutrition insecurity. Forty-nine percent of the country's population is considered under-

nourished; specifically, they lack access to the dietary energy required for a healthy, active life (5). Among children aged under 5y, 40% are too short for their age (i.e., they are stunted) (5). This suggests that a significant share of the population is subject to nutrient inadequacy, which can have lifelong, irreparable repercussions. Undernourishment affects not only human health, physical development, and cognitive development but also educational outcomes and wider economic development

(6, 7). Malagasy policy makers, nongovernmental organizations, and international donors have recognized the need for taking action to address malnutrition in Madagascar (8, 9).

Nutrition-specific and nutrition-sensitive development interventions, implemented by governments or civil society, can improve the situation. Nutrition can be improved, for example, by targeting the productivity of agricultural production or building nutrition awareness (10, 11). However, not all types of interventions are equally likely to succeed in all contexts, given the heterogeneous economic, biophysical, and cultural settings. To allocate resources effectively and maximize adoption of promoted behaviors among the target group, there is a need for identifying locally suitable development pathways (12, 13). Involving the target group through participatory methods is an important approach to ensure that planned activities are aligned with local preferences, experiences, and aspirations (14, 15). Participatory ex ante impact assessments are research processes through which targeted individuals—who are familiar with the local context and previous intervention efforts—deliberate and express their expectations about the likely impacts of proposed development interventions in advance, in a systematic quantitative way (14, 16). Such assessments can help development stakeholders with selecting interventions that are likely to be effective in specific local contexts. Furthermore, they may reveal the relevant heterogeneity of preferences and expectations within the target group. For example, women and men can have divergent preferences regarding food and nutrition security (FNS) interventions (16–18). Because in many places, participatory deliberations are prone to being dominated by men, results risk overemphasizing men's preferences and aspirations (19, 20). Insufficient attention to gendered preferences can result in men benefiting more strongly from intervention programs. Increased commercialization of farm outputs, for example, can improve household food security but may disempower women (21). A thorough understanding of heterogeneity within the target group—for example, between women and men—can help development stakeholders design intervention packages that integrate heterogeneous needs and preferences. Alternatively, it may inform the tailoring of different intervention packages to different target groups.

Another important aspect for selecting interventions relates to possible trade-offs. Positive effects on FNS can be accompanied by negative effects, leading to low levels of adoption or rapid disadoption of practices that initially seemed popular. For example, increases in staple yields may be realized at the expense of increased labor burden (22) or increased soil erosion (23). The promotion of income-increasing activities, without effective behavior change communication, can disempower women within their households and negatively affect time spent on childcare (17, 21). To what extent farmers are willing to accept such trade-offs is hard to foresee without their involvement. To avoid promoting activities with unintended strong negative effects, participatory ex ante impact assessment can provide a multidimensional perspective on intervention options, including potential benefits and disbenefits (16).

In this case study from rural Madagascar, a participatory methodology was applied to assess gender-disaggregated priorities, preferences, and multidimensional ex ante impact expectations regarding FNS interventions. To inform effective development strategies in the study region, our goal is to identify interventions that are likely to be adopted and have strong positive effects. To this end, we elicited intervention preferences



FIGURE 1 Municipalities where research was conducted in the Atsimo Atsinanana region (blue-shaded areas).

and impact expectations from potential beneficiaries of an upcoming food security intervention project. All analyses were disaggregated by gender and geographic location. Based on the combined insights from multiple participatory methods, the article suggests a possible prioritization of intervention options for the study region.

Methods

Research area

The Atsimo Atsinanana region is located in southeastern Madagascar, with a total area of 18,373 km² (24). Among its 5 districts, our study focused on the 3 most populated: Vondrozo, Farafangana, and Vangaindrano (Figure 1). These districts are home to about 80% of the region's population, with a population density of 54.4 habitants/km² (24). There are 3 main ethnic groups in the study area: Antaifasy (mostly in Farafangana and Vondrozo), Antaisaka (mostly in Vangaindrano), and Bara (mostly in Vondrozo). In addition, there are several smaller ethnic groups, including the Zafisoro, Rabakara, Sahafatra, and Antemanambondro. The majority of the population consists of resource-poor smallholder farmers. Average farm sizes are very small, even by smallholder standards: >90% of all farmers have access to <0.5 ha (24). Generally, farmers work their own land using family labor; only a few rent land (24). The region has a hot and humid tropical climate (4, 24).

Although the Atsimo Atsinanana region is frequently affected by cyclones and flooding, drought is becoming an increasingly present challenge due to declining rainfall (4, 25). In part due to these hazards, food security levels are below the national average, with 55%–60% of the population classified as stressed or in crisis as of late 2021 (26). Nevertheless, the region's varied landscapes are suitable for a large variety of crops. Common cash crops include coffee (on 60%–80% of the farms) alongside cloves and pepper (24). The most important food crops are rice, cassava, sweet potatoes, and fruits (bananas, litchis, pineapples, and mangoes). In addition, 50% of smallholders rear local breeds of zebu cattle, pork, and poultry in low-input and low-productivity systems (24). Fishing, at sea and in rivers, is also a common source of livelihood.

TABLE 1 Overview of research workshops

Subregion	Geographic Location	Municipality (Commune)	Fokontany	Participants, n	
				Women's Workshop	Men's Workshop
Farafangana North	Inland	Evato	Mahazoarivo	9	7
Farafangana South	Coastal	Farafangana	Anosin'akoho, Amboanio, Mahafasa Ouest	7	7
Vangaindrano North	Inland	Ampasimalemy	Fenoarivo	7	7
Vangaindrano South	Coastal	Manambondro	Manambondro	7	7
Vondrozo	Inland	Ambodirano	Ambatomasy	7	7
Vondrozo	Inland	Manambidala	Manambidala	4	4

Data collection and analysis

Participatory workshops.

In December 2020, we conducted 12 research workshops in 6 municipalities (*communes*) of 3 districts in the Atsimo Atsinanana region. These workshops were distributed across the intervention zone of an FNS intervention project carried out by the GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit; German Agency for International Cooperation). This project categorized the intervention zone into 5 subregions (Table 1). With the staff of the GIZ and DRAEP (Direction Régionale de l'Agriculture, l'Élevage et de la Pêche; Regional Direction of Agriculture, Livestock, and Fisheries), we purposefully identified 1 municipality considered typical of each subregion regarding farming systems and socioeconomic conditions. In each municipality, one *fokontany* (subdivision of municipality grouping multiple villages) was selected through discussions with the municipal mayor. In each fokontany, we organized 1 women-only and 1 men-only workshop, each with 7–9 participants. For reasons of time constraint, just 4 participants were invited to each workshop in Manambidala (Vondrozo district), and the women's and men's workshops were both carried out in a half day's time. This was done because participants had relatively long walking times to join the workshop location, and an overnight stay for the researcher in Manambidala was advised against for security reasons. Participants were, in all cases, recruited by the fokontany chief following our request to represent diversity in age, main livelihood activities, standard of living, and distance to the main market. Women were sampled from the reproductive age range (15–49 y), whereas men needed to be household head, resulting in an age range from 20 to 63 y. In one subregion, Farafangana South, the participants were recruited from 3 fokontany, all located in the center of the municipality. In total, 80 smallholder farmers participated in the activities (41 women, 39 men).

Except in Manambidala, each workshop lasted a full day and involved 2 main activities. First, we elicited participants' preferences for several FNS interventions by presenting 14 options and letting each participant select his or her personal "top 3" (see Eliciting Preferences for Potential FNS Interventions section). Second, we assessed the expected positive and negative effects of these interventions on selected livelihood criteria through participatory ex ante impact assessment (see Participatory Ex Ante Impact Assessment section). The underlying objective of identifying intervention preferences and expected effects was to determine which FNS interventions had highest probability of being widely accepted and adopted by the target group. All activities were carried out in Malagasy language by the first author.

Before carrying out the workshops, the methodology was discussed with and approved by DRAEP in Atsimo Atsinanana. All 6 municipal mayors, as well as the fokontany chiefs (local authorities), granted authorization for the research to be carried out. Oral consent was obtained from all workshop participants individually on the aspects of participation, voice recordings, and photography. Before beginning research activities, participants were informed that results would be shared with the wider public in an aggregated anonymized form (scientific publication). Data were recorded anonymously on the spot: only the participant's gender was recorded in addition to one's intervention preferences and impact assessment data. To appreciate the farmers' time commitment, all workshop participants were paid a compensation roughly equivalent to a day of farm labor (5000 Malagasy ariary, about US\$1.30).

Eliciting preferences for potential FNS interventions.

To identify which interventions smallholder farmers would be most interested in, a set of 14 potential interventions was defined, and participants' preferences were elicited regarding these options. This set was defined by an earlier study that identified locally promising interventions through interviews with organizations that have been implementing FNS intervention projects in Madagascar in recent years (27). From that study, 11 interventions were selected according to their viability considering the resources, time frame, and mandate of the intervention project by the GIZ. In addition, 3 more options were added purposefully, as these were under consideration by the planners of the intervention project. These options included food vouchers, poultry production support, and storage and preservation. For ethical reasons, we avoided including any intervention options that could not possibly be realized under the GIZ intervention project. This was done to avoid creating hopes that would eventually be disappointed with certainty. The 14 intervention options broadly target 4 mechanisms of FNS improvement: dietary habits; intensification of agriculture and livestock production; water, sanitation, and hygiene (WASH); and household income and finances (Table 2).

All interventions were explained to the workshop participants, aided by printed visualizations (Supplemental Material A). To ensure that all participants understood the intervention options in the same way and to stimulate thinking about their pros and cons, a SWOT analysis (strengths, weaknesses, opportunities, threats) was facilitated for each intervention (results not reported). After this, each participant verbally stated the 3 interventions that she or he would personally be most interested in. We summed the number of times that each

TABLE 2 FNS intervention options presented to workshop participants¹

FNS Intervention Category: Option	Description
Dietary habits	
Nutrition education	Trainings about nutritious and healthy food
Biofortified food	Sensitization on enriched food
Cooking demonstration	Practical demonstration on cooking nutritious and healthy food
Food vouchers	Distribution of vouchers for buying diverse food items
Agriculture and livestock production	
Kitchen garden	Trainings and input distribution for small-scale horticulture
Farmer field school	Technical trainings on food crop production
Cash crop trainings	Technical trainings on cash crop production
Poultry production support	Technical trainings on poultry production and input distribution
Storage and preservation	Awareness raising and trainings on food storage and preservation techniques
Pigs and other small livestock	Technical trainings on small livestock production
WASH	
Promotion of hygiene behavior	Sensitization about hand washing, water boiling, and latrine usage
Household income and finances	
Farmer organization	Establishment of farmer groups for shared cropping and/or marketing
Village savings and loans association	Establishment of local savings associations that provide credit to members
Financial education	Training on financial management, cash flows of the farm and household

¹FNS, food and nutrition security; WASH, water, sanitation, and hygiene.

intervention was included by participants among the top 3 preferred interventions. We later disaggregated these preferences by gender and by location (coastal/inland sites), a proxy for the degree of market orientation. Coastal sites tend to rely more strongly on cash crop production and purchased food, whereas inland sites are more subsistence oriented.

Participatory ex ante impact assessment.

To assess smallholder farmers' expectations regarding the diverse effects of potential FNS interventions, we adapted a methodology for participatory impact assessment (14). This included 2 stages (**Supplemental Material B**). In the first stage, workshop participants jointly ranked 8 potential impact dimensions by their importance. This served to understand farmers' principal aspirations—specifically, what types of impacts they were hoping for. In contrast to Schindler et al. (14), who codefined the criteria with farmers, we selected 8 relevant criteria from the literature on FNS and rural development outcomes (14, 18, 28–30). Our choice of criteria was also informed by our understanding about key development concerns, based on informal discussions with local farmers, rural authorities, and development practitioners active in the region.

The criteria were defined and explained individually to the workshop participants by using local examples. The following definitions were provided. *Food diversification* refers to an increase in the diversity of household diets—namely, an increase in the diversity of side dishes accompanying staples. *Food self-sufficiency* refers to the capacity of consuming self-produced staple food throughout the entire year. *Gender relations* refers to the perceived quality of interactions between women and men within the household, focusing on the general level of agreement in joint decision making about any household issues. *Income* refers to the net effect of the intervention on positive and negative cash flows of the household—that is, increases in household income or expenditures. *Labor burden* refers to the amount of time that household members need to allocate to livelihood activities, such as farming, trading produce, or caring for animals. *Resilience* refers to the capacity of the household to

buffer and recover from shocks, such as cyclones. *Skills and knowledge* refers to an increase in accessible information and practical abilities that are applicable beyond a specific FNS intervention. *Well-being* refers to the fulfilment of perceived basic household needs other than food, such as health and security. The same set of criteria was used in all workshops. We did this because we were interested in systematically measuring differences in priorities by gender and between locations, which would have been challenging with different sets of criteria. Workshop participants were asked to rank the criteria of potential intervention effect by their relative importance. At each workshop, the participants discussed and collectively agreed on a ranking.

In the second stage, each participant individually expressed his or her impact expectation for each of the 14 interventions in each of the 8 criteria. These assessments were given per the following rating scale: +3, +2, and +1 for strong, moderate, and weak positive impact; 0 for no expected impact; and –3, –2, and –1 for strong, moderate, and weak negative impact, respectively. To minimize complexity, we first focused on positive impacts. We laid out the visual representations of all 14 interventions on a table. We then went through all impact criteria one after another. For each criterion, each participant laid between 0 and 3 small stones on the images, according to one's expectations about positive impacts. There was no minimum or maximum number of stones that had to be allocated in total across all interventions. This rating was done individually, one participant after another. The number of stones laid on each image by each participant was noted; then, the stones were removed. After that, the next participant started a stone rating. When all participants had given their ratings, we moved to the next criterion. Eventually, the entire exercise was repeated for negative impacts. Where individual participants indicated positive and negative impacts for an intervention regarding the same criterion, we added the 2 scores [e.g., +3 + (–1) = +2]. Allocating positive and negative scores can be reasonable from the participant's perspective, as the number of stones may also reflect the relative probability of positive/negative impacts. For

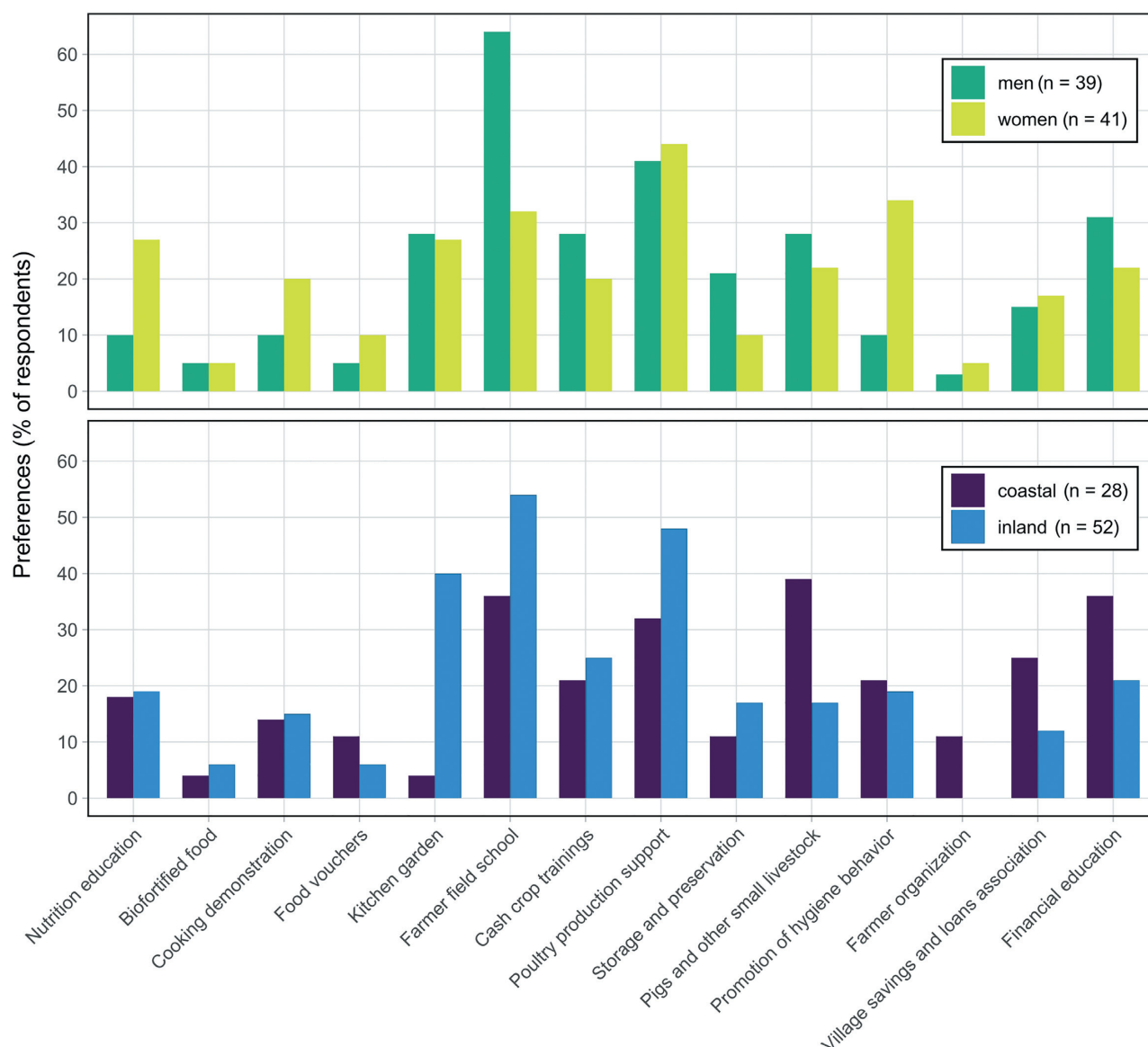


FIGURE 2 Intervention preferences split by gender and location. Bar height indicates share of respondents who included the intervention in their “top 3” selections.

example, a participant may perceive a high probability for positive impacts (+3) coexisting with a low risk of negative impacts (−1). In our analysis, we would have considered this a moderate positive impact (+2).

Results

Preferences for intervention options

The 80 smallholder farmers highlighted their individual top 3 most preferred interventions among 14 suggestions. The most popular interventions included farmer field school (included by 48% of all participants), technical support for poultry production (43%), and kitchen gardens (28%). The top priorities were similar between genders, with farmer

field school and technical support for poultry production among the 3 most preferred interventions for women and men.

Nevertheless, we found gendered preferences for several interventions. **Figure 2** provides an overview of intervention preferences, disaggregated by gender. Notably, the WASH intervention (promotion of hygiene behavior) was the second-most popular intervention among women but was considerably less preferred by men. Interventions targeting dietary habits, such as nutrition education or cooking demonstrations, were also generally more preferred by women than men. In contrast, most interventions targeting agriculture and livestock production were more popular with men than women, such as farmer field school, technical support for cash crop production, and trainings on storage and preservation of farm produce. There were 2 exceptions where women and men showed similar preference levels: kitchen garden

TABLE 3 Priority rankings of potential impact dimensions¹

Rank	Overall	Women	Men	Inland	Coastal
1	Income	Income	Income	Income	Income
2	Food self-sufficiency	Food self-sufficiency	Food self-sufficiency	Food self-sufficiency	Skills and knowledge
3	Skills and knowledge	Skills and knowledge	Skills and knowledge	Gender relations	Food self-sufficiency
4	Gender relations	Gender relations	Gender relations	Skills and knowledge	Gender relations
5	Labor burden	Well-being	Labor burden	Labor burden	Resilience
6	Well-being	Labor burden	Resilience	Well-being	Labor burden
7	Resilience	Food diversification	Well-being	Resilience	Well-being
8	Food diversification	Resilience	Food diversification	Food diversification	Food diversification

¹Dimensions are ordered by their mean rank from all relevant workshops. For the mean ranks, see Table 1 in **Supplemental Material C**.

and technical support for poultry production. Results were mixed regarding interventions targeting household income and finances.

Although men were more interested than women in financial education, women showed a slightly stronger preference for village savings and loans associations. Between genders, interest in farmer organizations was low.

Intervention preferences differed by location (Figure 2). Generally, preferences for agriculture and livestock interventions were stronger at the more subsistence-oriented inland sites (with the exception of “pigs and other small livestock”). In contrast, interventions targeting household income were more strongly favored at coastal sites, which are more suitable for cash crop production (especially cloves) and where farmers are more commercially oriented. Preferences were similar for interventions targeting WASH and dietary habits, though vouchers were more preferred in coastal areas.

Expectations regarding intervention impacts

In all workshops, the participants agreed on the relative importance of 8 dimensions of potential intervention impacts (Table 3). Overall, the highest priority was income, suggesting that farmers would welcome interventions that are expected to increase their income. There was agreement between genders on the top 4 priorities: income, food self-sufficiency, skills and knowledge, and gender relations. Minor differences in priorities between women and men appeared in the 4 lower-ranking criteria, where ranks differed by 1.

The priority rankings of impact criteria were more different between inland and coastal locations than between genders. Income was the highest priority in inland and coastal subregions. But whereas skills and knowledge was the second-highest priority in the coastal subregions, it ranked only fourth in inland subregions. Similarly, resilience was 2 ranks higher in coastal subregions than in inland subregions. Across all genders and subregions, food diversification ranked lowest or second lowest in priority.

Figure 3 shows ex ante impact assessment outcomes for 14 intervention options based on mean scores from 80 participants. Results show that the different interventions were expected to have diverging impacts, including negative ones, depending on impact dimension. Across impact dimensions, all interventions had more positive than negative scores, with 2 interventions (kitchen garden and vouchers) having no negative scores at all. In particular, for skills and knowledge, well-being, and food diversification, all interventions were expected to have positive or neutral impacts. However, a majority of interventions (9 of 14) were expected to have negative impacts on labor burden.

Discussion

To effectively improve the FNS of the rural population in southeastern Madagascar, the choice of interventions must be tailored to the local context (30). The observed heterogeneity of local people's priorities and preferences regarding different interventions underscores the need to consider beneficiaries' perceptions and preferences. We found that farmers generally see increased income and food self-sufficiency as their top development priorities. Given the high prevalence of poverty and undernourishment in the region, it can be expected that farmers prioritize short-term needs over long-term development goals (31, 32). That is, for many farmers, increasing per capita calorie supply may matter more than building resilience or improving family health by diversifying diets. This may also explain why food diversification was given very low priority overall. Current diets in the study region are little diversified despite agroclimatic potential for diversified subsistence farming (33). A high prevalence of undernourishment, attributed to the recurrently inadequate supply of staple food during the lean period, may contribute to the low priority assigned to dietary diversification. Farmers may see all investments into diverse diets (in terms of farmland, labor, or cash) as competing with staple food production or acquisition. For example, during our study, a farmer in Mahazoarivo Farafangana emphasized the superior importance of satisfying staple food needs before diversifying diets with vegetables: “Personally, I will only grow them once my family has enough food to eat.” A farmer in Ampasimalemy Vangaindrano explained how insufficient supply with staples currently precludes diversification: “We just need enough satiating food, such as rice or cassava, then we can work and grow everything. . . . During lean period we cannot work, we are too weak.”

Within the local, small-scale, predominantly subsistence-oriented farming systems, better food access is most likely to be achieved through increased farm productivity for either home consumption or sale. Consequently, farmers generally emphasize interventions geared toward increasing farm output. Overall, farmer field schools were the most preferred intervention. This was also the intervention with highest positive expectations regarding food self-sufficiency. Agricultural interventions with income-generating potential, such as poultry production support or kitchen gardens, were strongly preferred. In contrast, an emphasis on nonfarming income—instead of intensifying production—has been shown to have positive (29) or negative (34) effects on rural livelihoods. Given the limited nonagricultural opportunities in rural Atsimo Atsinanana, however, off-farm income acquisition seems an unlikely strategy unless farmers accept outmigration.

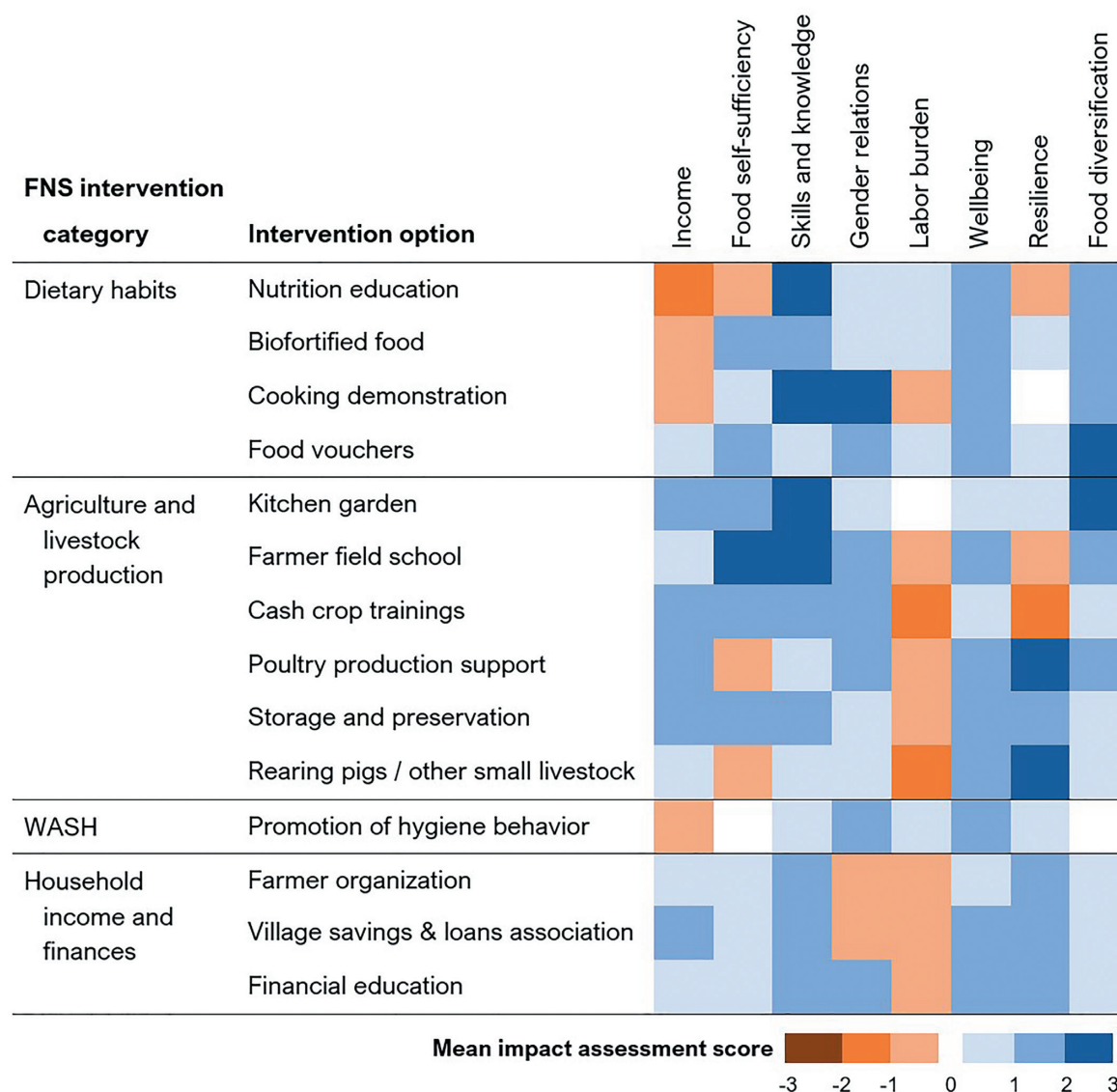


FIGURE 3 Ex ante impact assessment results; average of 80 participants. Assessment criteria (columns) are ordered by descending priority (Table 3). Color coding serves better overview; for mean scores, see Table 2 in Supplemental Material C. FNS, food and nutrition security; WASH, water, sanitation, and hygiene.

Women and men differed in their preferences for FNS interventions, but these differences do not suggest that any interventions are of exclusive interest to one group. Our study reflects findings from other smallholder contexts that associate family diets and health with women's responsibilities (35, 36). For example, women showed greater interest in cooking demonstrations and WASH interventions than men; instead, men were relatively more interested in cash crop trainings and value addition through storage and preservation. Interestingly, interest in kitchen gardens and poultry development—2 productive domains typically assumed as women's tasks—was similar between women and men. Equally high interest by women and men is encouraging, as it may suggest a high probability of adopting the respective practices. Increasing commercialization of originally women-managed poultry activities, however, can result in disempowerment of women (21). This can limit

the positive effect of increased household income on diet quality. It may be necessary to design interventions in a way that minimizes the risk of men taking over currently women-managed poultry activities. For example, it may help to specifically target women with knowledge-intensive trainings, for example, about animal health. Transversal approaches, such as community sensitization, may help to enhance adoption, as this may influence decision making at the individual and household levels (37).

Overall, differences between geographic locations seemed more pronounced than between genders. The stronger subsistence orientation of inland communities meant that food self-sufficiency was ranked higher here than in coastal communities, where farmers tend to participate more strongly in markets. Farmers from coastal subregions prioritized building new skills that would allow them to participate in markets and

benefit from cash income. These priorities are reflected by the most preferred intervention by geographic location: in inland subregions, this was farmer field school; in coastal subregions, it was trainings on rearing pigs or other small livestock, an almost exclusively market-oriented activity. Market potential has been shown to be one of the major forces shaping farming systems and livelihoods in the smallholder context (38). In line with this, the degree of subsistence compared with the market orientation, proxied in our study by inland compared with coastal location, has come out as a key determinant of intervention preference in the Atsimo Atsinanana region.

Our findings highlight the need for addressing farmers' needs and preferences with location-specific intervention packages. To maximize the adoption and impacts on the FNS situation of beneficiaries, development projects must tailor intervention packages to local preferences (39). For Atsimo Atsinanana, our findings suggest that development efforts should moderately emphasize subsistence agriculture, livestock, and horticultural production in inland subregions (e.g., farmer field school, kitchen gardens), whereas the focus should shift toward supplying local markets in coastal subregions (e.g., pig husbandry). The fact that the income criterion is consistently ranked as the top priority may suggest limited potential for interventions that could require targeted households to use scarce cash resources—for example, for purchasing food (e.g., nutrition education, biofortified food) or sanitary items (e.g., hygiene behavior). To be effective, these interventions involving behavior change communication about nutrition or hygiene may need to be strictly linked with activities directed at increasing income or food self-sufficiency, such as farmer field school, kitchen garden, or cash crop trainings (40, 41).

Increased labor burden stands out as a negative criterion for many, although not all, intervention options. This is relevant information for development stakeholders because trade-offs regarding labor availability were shown to limit adoption of promoted practices in the past (22, 42). Two interventions seem particularly labor intensive: cash crop trainings and rearing pig or other small livestock. Cash crop trainings are expected to bring strong benefits across the 4 most important impact criteria, potentially outweighing the increased drudgery. Farmers may also be able to hire external labor with income generated from increased cash crop productivity. For interventions on pig husbandry, however, these effects are weak or even negative on average, making adoption unlikely. A thorough understanding of gender roles can help design and target interventions in a way that distributes increased workload more equitably (20, 43). In an example from Atsimo Atsinanana, vegetable gardening was indeed perceived favorably but risked overburdening women already busy with household chores and childcare. In consequence, the authors of that study suggested targeting kitchen gardens at youth rather than women (44). In contrast to these findings, our participants expected a neutral net effect of kitchen gardens on labor burden. In group discussions during the SWOT analyses, farmers argued that, despite requiring labor, increased vegetable production could reduce the time spent at markets, which would save time and free up labor resources.

Farmer-participatory assessments can suffer from agreement bias, where farmers overstate positive expectations and underrate negative aspects to avoid offending the researcher (45). Overall, however, our data on farmers' ex ante impact expectations involve substantial variation, including ≥ 1 mean negative score for all but 2 interventions. Al-

though respondents' tendency toward agreement might have influenced their assessments, this effect would have affected all interventions and all criteria in the same way. Therefore, we do not expect that agreement bias affected our analysis substantially. Furthermore, the purposive recruitment of workshop participants by the fokontany chief, rather than random sampling, might have affected the representativeness of participants, which may restrict the generalizability of our results to other farmers in the region (46). Replications of our approach in other regions should intend to engage a random population sample. Proper representativeness, though, is hard to achieve in the absence of population-level statistics and with the typically small numbers of participants involved in participatory research.

Despite not having experienced the interventions firsthand, participants had nuanced views on potential positive and negative impacts of potential FNS interventions. Our results demonstrate the value of participatory ex ante impact assessments for discarding interventions with strong negative effects and prioritizing interventions with positive effects in important criteria. Achieving long-term FNS impacts may require going beyond immediate food systems interventions (targeting production, acquisition, or consumption). For example, children's nutrition status can possibly be improved by enhancing mothers' economic autonomy through land access, as well as fathers' awareness of childcare needs (47, 48). In addition to addressing individual household behaviors, development stakeholders may achieve desired outcomes by building social safety nets (e.g., insurance schemes for coastal residents against cyclone damage); improving access to schooling; or upgrading the distribution of high-yielding, climate-adapted, and biofortified crop varieties (10, 49, 50).

In conclusion, by highlighting diverse preferences as well as simultaneous positive and negative impact expectations, this study demonstrates the importance of considering community perceptions regarding FNS interventions prior to project implementation. This way, development stakeholders can identify interventions that are interesting for both genders, thus maximizing impacts. Because the dominant type of livelihood influences local intervention preferences, the approach allows for tailoring intervention packages to the local context—for example, separately for coastal and inland subregions of Atsimo Atsinanana. Moreover, determining positive and negative impact expectations through ex ante impact assessment can enable development stakeholders to select interventions according to beneficiaries' priorities and avoid strong trade-offs. Efforts for improving the FNS of rural smallholders can benefit from characterizing interventions with the target group to ensure that they address local needs and priorities.

For the Atsimo Atsinanana region of Madagascar, our findings suggest great potential for the implementation of farmer field schools and kitchen gardens in inland areas, whereas coastal areas will benefit from supporting pig husbandry and other market-oriented farming activities. At the same time, development stakeholders interested in reducing malnutrition may need to implement interventions that increase awareness for the importance of dietary diversity. The opportunities and challenges identified in this case study may support FNS projects in the Atsimo Atsinanana region that maximize impacts by designing a tailored intervention package based on local preferences and priorities. In particular, insights on negative impact expectations of selected interventions can be useful to anticipate coping strategies.

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Data Availability

Data described in the article have been made publicly and freely available without restriction at <https://doi.org/10.6084/m9.figshare.19844809>.

References

1. Tadross M, Randriamarolaza L, Rabefitia Z, Yip Z. Climate change in Madagascar, recent past and future. Antananarivo (Madagascar): Meteo Malgasy; 2008.
2. Harvey CA, Rakotobe ZL, Rao NS, Dave R, Razafimahatratra H, Rabarijohn RH, et al. Extreme vulnerability of smallholder farmers to agricultural risks and climate change in Madagascar. *Philos Trans R Soc Lond B Biol Sci* 2014;369(1639):20130089.
3. FAO. Climate change and food security: risks and responses. Rome (Italy): Food and Agriculture Organization of the United Nations; 2015.
4. Rakotoarison N, Raholijao N, Razafindramavo LM, Rakotomavo Z, Rakotoarisoa A, Guillemot JS, et al. Assessment of risk, vulnerability and adaptation to climate change by the health sector in Madagascar. *Int J Environ Res Public Health* 2018;15(12):2643.
5. FAO. The state of food security and nutrition in the world 2022: repurposing food and agricultural policies to make healthy diets more affordable. Rome (Italy): Food and Agricultural Organization of the United Nations; 2022.
6. Alderman H, Hoddinott J, Kinsey B. Long term consequences of early childhood malnutrition. *Oxford Economic Papers* 2006;58(3):450–74.
7. Siddiqui F, Salam RA, Lassi ZS, Das JK. The intertwined relationship between malnutrition and poverty. *Front Public Heal* 2020;8:453.
8. République de Madagascar. Plan National d'Action pour la Nutrition-III 2017–2021 [Internet]. Antananarivo (Madagascar); 2017. Available from: <http://extwprlegs1.fao.org/docs/pdf/Mad172682.pdf>.
9. World Bank. World Bank supports Madagascar to reduce child stunting through a transformative new 10-year program. Washington (DC): World Bank Group; 2017. Press release 2018/062/AFR
10. Ruel MT, Alderman H. Maternal and Child Nutrition Study Group. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *Lancet North Am Ed* 2013;382(9891):536–51.
11. del Carmen Casanovas M, Lutter CK, Mangasaryan N, Mwadime R, Hajebehoy N, Aguilar AM, et al. Multi-sectoral interventions for healthy growth. *Matern Child Nutr* 2013;9:46–57.
12. Schindler J, Graef F, König HJ, Mchau D. Developing community-based food security criteria in rural Tanzania. *Food Security* 2017;9(6):1285–98.
13. Descheemaeker K, Ronner E, Ollenburger M, Franke AC, Klapwijk CJ, Falconnier GN, et al. Which options fit best? Operationalizing the socio-ecological niche concept. *Exp Agric* 2019;55(Suppl 1):169–90.
14. Schindler J, Graef F, König HJ, Mchau D, Saidia P, Sieber S. Sustainability impact assessment to improve food security of smallholders in Tanzania. *Environ Impact Assess Rev* 2016;60:52–63.
15. Beyuo A, Anyidoho NA. An impact assessment of farmer participation on food security in Northwestern Ghana. *Eur J Dev Res* 2021. doi:10.1057/s41287-021-00444-7
16. Schindler J, Graef F, König HJ. Participatory impact assessment: bridging the gap between scientists' theory and farmers' practice. *Agric Syst* 2016;148:38–43.
17. Beuchelt TD, Badstue L. Gender, nutrition- and climate-smart food production: opportunities and trade-offs. *Food Security* 2013;5(5):709–21.
18. Graef F, Hernandez LEA, König HJ, Uckert G, Mnimbo MT. Systemising gender integration with rural stakeholders' sustainability impact assessments: a case study with three low-input upgrading strategies. *Environ Impact Assess Rev* 2018;68:81–89.
19. Cornwall A. Whose voices? Whose choices? Reflections on gender and participatory development. *World Dev* 2003;31(8):1325–42.
20. Mnimbo TS, Lyimo-Macha J, Urassa JK, Mutabazi KD. Pathways for addressing gender-based constraints for effective participation in profitable crop value chains in Tanzania. In: Bamutaze Y, Kyamanywa S, Singh B, Nabanoga G, Lal R, editors. *Agriculture and ecosystem resilience in sub Saharan Africa livelihood pathways under changing climate*. Cham (Switzerland): Springer; 2019. p. 653–71.
21. Tavenner K, van Wijk M, Fraval S, Hammond J, Baltenweck I, Teufel N, et al. Intensifying inequality? Gendered trends in commercializing and diversifying smallholder farming systems in East Africa. *Front Sustain Food Syst* 2019;3:1–14.
22. Moser CM, Barrett CB. The disappointing adoption dynamics of a yield-increasing, low external-input technology: the case of SRI in Madagascar. *Agric Syst* 2003;76(3):1085–100.
23. Tittone P, van Wijk MT, Rufino MC, Vrugt JA, Giller KE. Analysing trade-offs in resource and labour allocation by smallholder farmers using inverse modelling techniques: a case-study from Kakamega district, western Kenya. *Agric Syst* 2007;95(1–3):76–95.
24. CREAM. Monographie Région Atsimo Atsinanana. Antananarivo (Madagascar): Centre de Recherches, d'Études, de d'Appui à l'Analyse Économique de Madagascar; 2013.
25. Weiskopf SR, Cushing JA, Morelli TL, Myers BJE. Climate change risks and adaptation options for Madagascar. *Ecol Soc* 2021;26(4):36.
26. Integrated Food Security Phase Classification. Madagascar—Grand Sud and Grand Sud-Est: analyse de l'insécurité alimentaire aiguë et de la malnutrition aiguë [Internet]. IPC; 2021. Available from: https://www.ipcinfo.org/fileadmin/user_upload/ipcinfo/docs/IPC_Madagascar_Food_Security_Nutrition_Report_French.pdf
27. Konzack A, Steinke J, Rafanomezantsoa AS, Tojo-Mandaharisoa S. Expert-based analysis of successful intervention strategies for enhancing food and nutrition security in Madagascar [Internet]. Berlin (Germany): Humboldt University Berlin; 2020. Available from: <https://www.doi.org/10.13140/RG.2.2.21778.53445>
28. Dostie B, Haggblade S, Randriamamonjy J. Seasonal poverty in Madagascar: magnitude and solutions. *Food Policy* 2002;27(5–6):493–518.
29. Neudert R, Goetter JF, Andriamparany JN, Rakotoarisoa M. Income diversification, wealth, education and well-being in rural south-western Madagascar: results from the Mahafaly region. *Development Southern Africa* 2015;32(6):758–84.
30. Briones Alonso E, Cockx L, Swinnen J. Culture and food security. *Global Food Security* 2018;17:113–27.
31. Nakhumwa TO, Hassan RM. Optimal management of soil quality stocks and long-term consequences of land degradation for smallholder farmers in Malawi. *Environ Resour Econ (Dordr)* 2012;52(3):415–33.
32. Alemayehu M, Beuving J, Ruben R. Disentangling poor smallholder farmers' risk preferences and time horizons: evidence from a field experiment in Ethiopia. *Eur J Dev Res* 2019;31(3):558–80.
33. Randrianarison N, Nischalke S, Andriamazaoro H. The role of biodiversity and natural resource management in food security in south-eastern Madagascar. *Acta Hort* 2020;1267:267–74.
34. Islam MM, Sarker MA, Al Mamun MA, Mamun-ur-Rashid M, Roy D. Stepping up versus stepping out: on the outcomes and drivers of two

- alternative climate change adaptation strategies of smallholders. *World Dev* 2021;148:105671.
35. Doss CR. Designing agricultural technology for African women farmers: lessons from 25 years of experience. *World Dev* 2001;29(12): 2075–92.
 36. Charmes J. A review of empirical evidence on time use in Africa from UN-sponsored surveys. In: Blackden CM, Wodon Q, editors. *Gender, time use, and poverty in sub-Saharan Africa*. Washington (DC): The World Bank; 2006. p. 39–72.
 37. Dierickx S, O'Neill S, Gryseels C, Immaculate Anyango E, Bannister-Tyrrell M, Okebe J, et al. Community sensitization and decision-making for trial participation: a mixed-methods study from the Gambia. *Dev World Bioeth* 2018;18(4):406–19.
 38. Tittone P. Livelihood strategies, resilience and transformability in African agroecosystems. *Agric Syst* 2014;126:3–14.
 39. Fiorella KJ, Chen RL, Milner EM, Fernald LCH. Agricultural interventions for improved nutrition: a review of livelihood and environmental dimensions. *Global Food Security* 2016;8:39–47.
 40. Bonuedi I, Gerber N, Kornher L. Intervening in cash crop value chains for improved nutrition: evidence from rural Sierra Leone. *Journal of Development Studies* 2022;58(1):38–54.
 41. Reinbott A, Schelling A, Kuchenbecker J, Jeremias T, Russell I, Kevanna O, et al. Nutrition education linked to agricultural interventions improved child dietary diversity in rural Cambodia. *Br J Nutr* 2016;116(8): 1457–68.
 42. Giller KE, Witter E, Corbeels M, Tittone P. Conservation agriculture and smallholder farming in Africa: the heretics' view. *Field Crops Research* 2009;114(1):23–34.
 43. Cole SM, Puskur R, Rajaratnam S, Zulu F. Exploring the intricate relationship between poverty, gender inequality and rural masculinity: a case study from an aquatic agricultural system in Zambia. *Culture, Society and Masculinities* 2015;7:154–70.
 44. Nischalke SM, Abebe M, Assefa B, Keding GB, Kriesemer SK, Randrianarison N, et al. Gender challenges in horticultural research in Ethiopia and Madagascar. *Acta Hort* 2018;1205(1205):137–46.
 45. Ali DA, Bowen D, Deininger K. Personality traits, technology adoption, and technical efficiency: evidence from smallholder rice farms in Ghana. *Journal of Development Studies*. 2020;56(7):1330–48.
 46. Sharma G. Pros and cons of different sampling techniques. *International Journal of Applied Research* 2017;3:749–52.
 47. Abate KH, Belachew T. Women's autonomy and men's involvement in child care and feeding as predictors of infant and young child anthropometric indices in coffee farming households of Jimma Zone, South West of Ethiopia. *PLoS One* 2017;12(3):e0172885.
 48. Komakech J, Walters C, Rakotomanana H, Hildebrand D, Stoecker B. Women's empowerment measures and their association with child dietary diversity and child nutritional status: findings from DHS form eight East African Countries (P10-007-19). *Curr Dev Nutr* 2019;3 Suppl 1: nzz034.
 49. Arouna A, Lokossou JC, Wopereis MCS, Bruce-Oliver S, Roy-Macauley H. Contribution of improved rice varieties to poverty reduction and food security in sub-Saharan Africa. *Global Food Security* 2017;14: 54–60.
 50. Bouis HE, Saltzman A. Improving nutrition through biofortification: a review of evidence from HarvestPlus, 2003 through 2016. *Global Food Security* 2017;12:49–58.