SEED SYSTEM SECURITY ASSESSMENT IN SOUTHEAST MADAGASCAR

USAID FROM THE AMERICAN PEOPLE

ADRA

ACKNOWLEDGMENTS

This Seed System Security Assessment (SSSA) was funded by the United States Agency for International Development (USAID) as part of the Agricultural Response in Southeast Madagascar II (ARISE-II) Emergency Project Award (Award No. 720BHA23GR00033), implemented by Adventist Development and Relief Agency (ADRA). The SSSA report was written by the primary consultant and team leader, Peter Shapland with contributions from Afia Agyekum. Dr. Louise Sperling provided technical support and guidance to the assessment team through funding provided by the USAID Bureau for Humanitarian Assistance (BHA)-funded Practice, Research, and Operations in Water, Sanitation, and Hygiene and Strengthening Capacity in Agriculture, Livelihoods, and Environment (PRO-WASH & SCALE) Award. Data management and analysis was conducted by Peter Gallagher. The team adapted SSSA methods developed by SeedSystem.org to perform this study. The study was implemented with the ARISE II Project team, including ARISE II Project Manager Vonjy Hajanirinaherintsoa (Haja) and a team of field agents (Toky Razafiharijaona, Tsilavina Rakotoarisoa, and Britto Alphose Andriniaina) who provided valuable input and support during the data collection and analysis. Emmanuel Awude, Verohanitra Razafindralambo, and Lanto Ramamonjisoa of ADRA Madagascar managed SSSA operations and traveled to the field to manage operations and logistics.

We are grateful to the **Ministry of Agriculture** in Atsimo Atsinanana, which provided professional staff to guide and support qualitative data collection teams, namely Nacya Raharinantenaina, Johnny Razafimahandry, Narcia Mangatsaradin, Jean laude Randrianantenaina, Yvon Andry Tahina, and Diary Randyriamahal. Final appreciation goes to all ADRA staff who provided their support at various levels to ensure this assessment was a success, particularly to Alejandra Lopez and ADRA consultant Dr. Fred Smith.

Assessment Team: Peter Shapland (Lead) with support from Louise Sperling and Patrick Gallagher.

Recommended Citation: Adventist Development and Relief Agency (ADRA) (2023), Seed System Security Assessment in Southeast Madagascar, ADRA ARISE II Project, Madagascar.

TABLE OF CONTENTS

ACRONYMS

ADRA	Adventist Development and Relief Agency
ARISE II	Agricultural Response in Southeast Madagascar (part 2)
CMD	Cassava Mosaic Disease
CTAS	Centre Technique Agro-écologique du Sud
DRA	Le Département de Recherches Agronomiques
DRR	Le Département de Recherches Rizicoles
FAO	Food and Agriculture Organization of the United Nations
FIFAMANOR	Fiompiana sy Fambolena Malagasy sy Norvegiana
FoFIFA	Foibe Fikarohana momba ny Fampandrosoana ny Ambanivohitra
Ha	Hectare
HH	Household
Kg	Kilogram
NGO	Non-governmental Organization
QDS	Quality-declared Seed
SADC	Southern African Development Community
SOC	Official Seed and Plant Material Control Service
SRI	System of Rice Intensification
SSSA	Seed System Security Assessment
WHH	Welt Hunger Hilfe

EXECUTIVE SUMMARY

This report presents the results of a Seed System Security Assessment (SSSA) in the districts of Farafangana and Vangaindrano (southeast Madagascar). This evaluation did not find an immediate seed security crisis that requires an emergency response or an immediate seed distribution. This SSSA did find chronic and acute stresses to the seed system. The chronic stress is the farmers' overreliance on the informal system. Famers rely on three main sources of seed: their saved stocks, informal seed markets, and social networks. In Farafangana and Vangaindrano, there is extremely low demand and supply of improved varieties from the formal seed sector. Improved varieties—such as short-cycle, high-performing, locally-adapted, and pest-resistant—play a significant role in any seed system, as they are a key source of innovation. Relying almost entirely on the informal system threatens the farmers' resilience to the shocks and stresses associated with a changing climate. The acute stresses are the cyclones, flooding, and droughts that impede (1) food security and (2) the adoption of improved varieties and modern agricultural practices. The chronic and acute stresses are interwoven. The acute stresses depress agricultural incomes and hinder intensive agricultural practices. Subsistence farmers are poorer as a result, making them less able to invest in improved varieties, leading to a moribund formal seed system that does not deliver innovative germplasm. To catalyze the formal seed system, development interventions need to address the low demand and the low supply of certified seed and quality-declared seed (QDS). This will require collaboration with diverse stakeholders from both the public and private sectors, emphasizing a long-term perspective.

Findings

- Signs of acute seed insecurity were not observed.
- Rice, sweet potato, and cassava are the most important staple crops.
- Agricultural production is still low, and farmers struggle with the rising variability in rainfall patterns and the increase in extreme weather events that result from climate change.
- Almost half of the households are headed by women due to male emigration; female-headed households were more likely to be among the most vulnerable.
- Farmers have three main sources of seed: their saved stocks, informal seed markets (including reliable informal traders specializing in seed), and social networks.
- Farmers' production strategies for their three main crops (rice, cassava, and sweet potato) are linked to the quantity of seed they access at the beginning of the agricultural season. Their production strategies for their three main crops are less dependent on the market price of their harvests.
- Sweet potato production is more resilient to cyclones than cassava production, and cassava production is more resilient to cyclones than rice production.
- Farmers obtain roughly 20% of their rice seed from their social networks, and almost all the rice seed obtained via their social networks is bought and sold.
- Farmers obtain over 40% of their cassava planting material from their social networks, with most exchanging in reciprocal relationships of mutual aid.

- Cassava and sweet potato cuttings are more likely to be exchanged within the gift economy because they are the most stable food source for vulnerable households, and their cuttings are harder to transport to market.
- Farmers were more interested in farming their traditional rice varieties than modern varieties.
- The labor constraint and climatic variability lead farmers to prefer traditional varieties and traditional (extensive) agricultural practices.
- Few farmers bought chemical fertilizer, dampening the potential yield benefits of the improved varieties that often require high soil fertility.
- Seed distributions reduce farmers' willingness to pay for certified seed.
- Certified seed producers struggle to obtain foundation seed.
- Certified seed producers are focused on selling seed to projects; informal seed producers are focused on selling seed to farmers.
- Informal seed producers and the local markets are major sources of seed and new varieties.
- Farmers' overreliance on traditional varieties results in very low demand for modern varieties. Improved varieties play a vital role in any seed system, as they are the main source of innovation. Relying almost entirely on the informal system threatens the farmers' resilience to the shocks and stresses associated with a changing climate.
- Development interventions need to catalyze the formal seed sector by stimulating demand and supply.
- The seed system lacks new, improved, climate-smart, pest-resistant varieties. The modern variety of rice found in Atsimo Atsinanana (X265) was released in 1986. One of the improved cassava varieties (Madarasy) was released in the 1950s, and the improved varieties of sweet potato found in the region (Bora and Irene) were released in the early 2000s and 2017, respectively.

These findings imply there are few or no acute seed shortages in the study area while poor seed quality, lack of new, adapted varieties, and limited availability of certified or quality declared seed at reasonable cost are chronic challenges in the seed system.

Recommendations

Overall, it's recommended to only distribute seed in response to acute seed stressors (cyclones, floods, droughts) in the region, and avoid repeated seed distributions unless there is an assessed need. To address both the demand and supply side constraints to ensure easy access to new adaptive varieties of seeds, it will require collaboration with diverse stakeholders from both the public and private sectors, emphasizing a long-term perspective.

To address the seed access gaps, it will require actions at the commune and district level:

a. At Commune level
    i. Increase demand for improved varieties, including disease resistant varieties, by implementing easily replicable farmer preference trials that include three or four improved varieties and a locally preferred variety. These trails should include exchange visits for farmers to observe the performance of the improved varieties compared with the traditional/ local varieties.
    ii. Implement field trails with seed multiplication groups and producers and support them to produce for sale quality seeds and planting materials, both local and improved varieties, that are successful at the trials.

iii. Increase the supply of disease-free cassava planting materials by training existing producers to remove diseased plants and training isolated farmers to become producers of quality-declared cassava planting materials.
iv. Implement farmer field schools using demonstration plots to demonstrate improved techniques that are more responsive to the shock/ stress. This can include improved seed varieties, if field trials have not been done in the communes already, and other climate smart production techniques, systems of rice intensification, etc.
v. Female-headed households often have less access to land and could be more open to intensification as a result. Encourage female-headed households to adopt quality seeds and improved varieties and agricultural intensification (if practices are proven) by demonstrating improved varieties with characteristics that are desired by women. Encourage female participation by making the demonstrations close to the villages and accessible. To fully understand the constraints to intensive production by these groups, further research should be conducted to ensure all factors that affect uptake of intensive production are well considered.
vi. Encourage agro-dealers, seed groups and producers to package and sell small packets of quality seeds and planting materials.
vii. Increase demand for QDS and improved varieties of seeds adaptive to the agroclimatic conditions and farmers needs by providing farmers with seed vouchers to buy down their risk to explore these quality seed types. These vouchers can be used for purchases at seed fairs or in other sales venues. This strategy uses a market-based approach that can increase demand for improved varieties by enabling farmers to experiment with small quantities of their choosing.

b. At District level
i. Increase demand for improved varieties by breeding and testing improved varieties of seeds and planting materials that respond to farmers' preferences and agroecological context, including those developed in member countries in the Southern African Development Community (SADC) for performance and preference studies before releasing them.
ii. Introduce promising registered varieties developed by seed breeding institutions, universities, government agencies, private sector companies and other innovative platforms through field trials with seed venders, multiplication groups and agro-dealers for uptake.
iii. Increase local supply of certified seeds by finding trusted seed vendors and agro-dealers to sell small packets of QDS and certified seed.
iv. Strengthen the seed supply market by supporting existing and new seed vendors and agro-dealers to expand customer base and reach more communes using models such as agro-agent model, weekly or monthly input/ market fairs, cost-share and loan guarantee models.
v. Increase demand for high-performing seeds by setting up financial mechanisms that provide seed loans to producers for high-performing seeds.

I. INTRODUCTION

Rationale for the Assessment

This report presents the results of a Seed System Security Assessment (SSSA) in the Farafangana and Vangaindrano districts in Atsimo Atsinanana (southeast Madagascar). Atsimo Atsinanana benefits from two rainy seasons per year. The main rainy season (Vatomandry) generally starts in November and ends in June, while the offseason occurs in the winter months. This SSSA focused entirely on the main rainy season and was conducted in collaboration with the regional Ministry of Agriculture in July and August 2023. This timing enables respondents of the individual survey to report on the quantity and quality of the seed they planted in last main rainy season and forecast the quantity of seed they intend to plant for the upcoming main rainy season.

The SSSA was conducted in the Farafangana and Vangaindrano Districts because:

- They comprise the target zones of the USAID-funded, nine-month Agricultural Response in Southeast Madagascar II (ARISE-II) project focused on a rapid response to the shocks of cyclones Batsirai and Emnati in affected communities. ARISE II has distributed 150 tons of rice seed, 120 tons of maize, 120 tons of bambara nuts, and 164,000 small packets of vegetable seed.
- They are in a highly productive agricultural zone subject to frequent cyclones, floods, and drought. This combination of high productivity and frequent shocks is an excellent agro-ecological context to show how a holistic, market-oriented approach to seed system development can contribute to self-reliance among smallholder farmers and self-determination among the governmental and private sector actors serving the farmers.

Report Structure

This report is structured into six sections, including this introduction. **Chapter II** reviews the background and key concepts of an SSSA. **Chapter III** discusses the general methodology and the range of survey tools of an SSSA. This chapter also dives into the methodological details of this SSSA, such as the rationale for the site selection and the demographics of the respondents. **Chapter IV** describes the social, agro-ecological, and legal contexts of the seed system in Atsimo Atsinanana. **Chapter V** provides descriptions and analyses of the seed system in Atsimo Atsinanana. This chapter analyses the demand and supply of seed. It is informed by 71 qualitative surveys of local actors in the formal and informal seed systems and 659 quantitative household surveys of smallholder farmers. **Chapter VI** presents recommendations to strengthen the seed system in Atsimo Atsinanana.

II. BACKGROUND TO SEED SYSTEM SECURITY ASSESSMENT (SSSA)

This chapter reviews the key concepts and methodology of the SSSA; it provides readers with conceptual tools to interpret the SSSA.

A seed system is comprised of three core sub-systems:

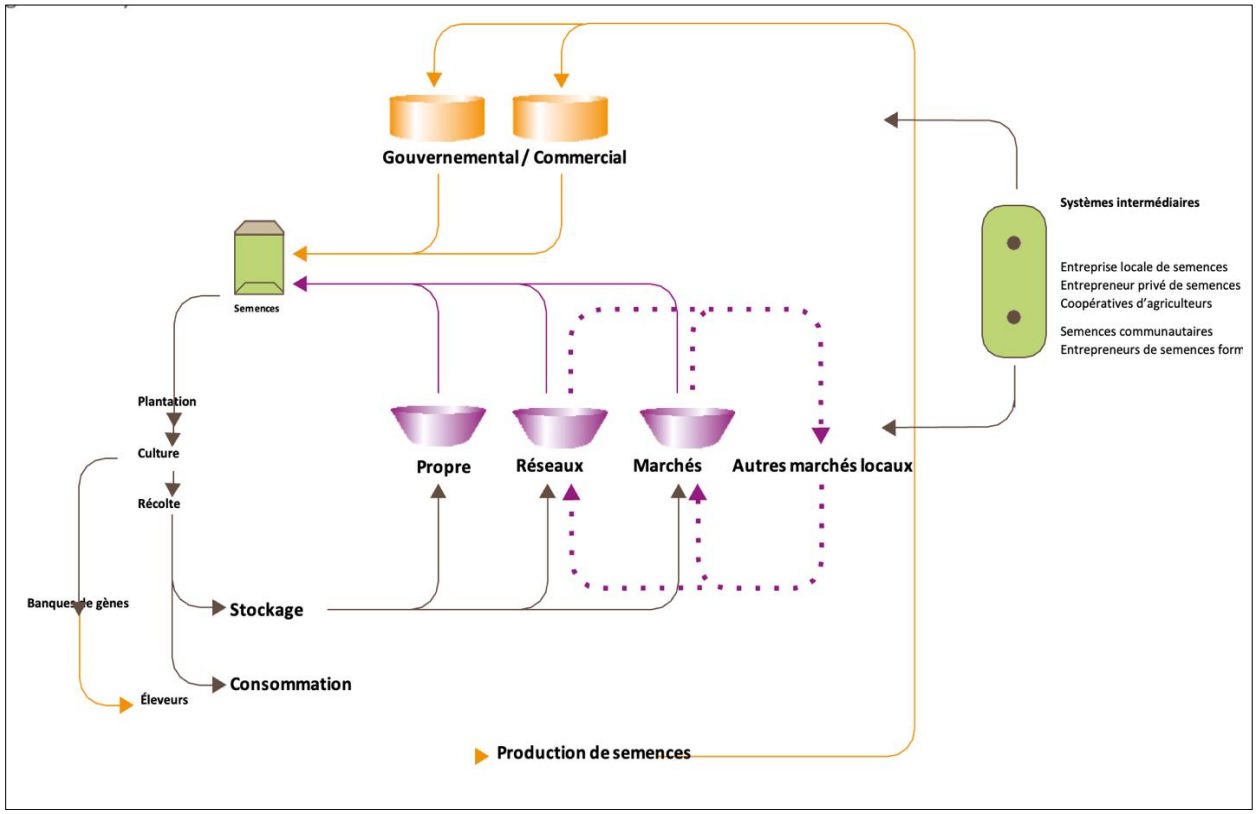
- The formal seed system generates and distributes improved (i.e., 'modern') varieties. Improved varieties are often bred at national-level research institutes and are typically multiplied by certified seed producers. A government body controls and verifies the quality of certified seed, and commercial companies market this seed. Improved varieties can also be rigorously multiplied as quality-declared seed (QDS), but this occurs less often.

- The informal seed system is where farmers produce, exchange, and procure their local/traditional varieties. Farmers acquire seed in the informal system from local grain markets, from exchanges with other farmers, and most importantly, from their own harvest (stored stock of seed). The informal seed system emerges organically from the farmers' unencumbered dealings with traditional and modern varieties, making it highly attuned to the farmers' localized preferences. This dynamic system is where farmers in the Global South acquire roughly 90% of their seed. Seed in this system can be hard to identify, as it is often produced, sorted, and sold as grain.

- The intermediary seed system consists of the seed flows between the formal and informal seed systems. Farmer associations trained by non-governmental organizations (NGOs) programs to rigorously multiply clean planting materials of sweet potato or cassava are an example of the intermediary seed system.

The three sub-systems of a seed system are entangled. For example, improved varieties are most often bred by scientists at national research institutes, multiplied by certified seed producers, and sold by commercial enterprises (see orange lines in Figure 1), but once farmers get a hold of these improved varieties, it enters their informal system (see purple lines in Figure 1). This is where farmers multiply seed, exchanging it within their social networks, selling it in the local markets, and replanting it the following year. The informal system is dominated by the farmers' local/traditional varieties that are highly adapted to their unique agro-ecological conditions. However, improved varieties flow through these informal systems as well. For example, when smallholder farmers see the benefits of an improved variety but cannot afford to purchase the certified seed, they will find wealthier farmers in their social networks who have purchased the certified seed, and the poorer farmers will request to exchange grain with the wealthier farmer after the harvest. This way, the poorer farmers can access the second generation of the improved variety. This second and subsequent generations of certified seed that enter the informal system often have reduced quality due to traditional production practices, higher levels of weed seed and inert materials, poor storage, and potential mixing with other varieties.

Figure 1: The interconnected formal, informal, and intermediary seed systems through which farmers procure seed



Source: Sperling, 2023

Seed Security

Seed security has three main components: availability, accessibility, and quality (see Table 1). Smallholder farmers achieve seed security when good quality seed is available and accessible. In the words of a female farmer in a focus group discussion in Vangaindrano: "*Seed security means that a household has the necessary seeds (either in its reserves or from the domestic harvest) or that it can obtain the required seeds, whether through purchase or exchange*."

Seed security is an essential component of food security. In general, farmers are most likely to reach self-reliance and the capacity to sustain their households and communities when good quality seed is available and accessible. However, food security does not necessarily entail seed security; for example, if an infestation diminishes a farmer's seed quality but not the edibility of their stored grain, they are food secure but not seed secure. Also, seed security does not necessarily lead to food security. For example, every year in the 'hungry season,' some smallholders have enough seed for the upcoming agricultural campaign but not enough food to eat. They face difficult choices as a result.

Table 1: Necessary Components of Seed Security

Component	Description
Available	Seed of sufficient quantity is present within reasonable proximity and in time for critical sowing periods.
Seed Health / Quality	Seed has good physical, physiological, and sanitary quality.
Varietal Quality	Varieties are adapted to the agro-ecological context and satisfy female and male farmers' marketing, processing, cooking, and consumption preferences.
Accessible	Farmers have adequate income or social capital to purchase, barter, or acquire good-quality seeds. Thus, availability and quality are pre-conditions for accessibility.

Source: Sperling et al., 2022

Seed availability concerns whether there is enough seed for a given crop within a reasonable distance of the farmers and at the time when they need it. Availability is a geographical and temporal component of seed security.

Seed quality concerns two general features. *Varietal quality* concerns genetic attributes, such as yield potential, resistance to drought, and palatability. *Seed health/quality* concerns the physical, physiological, and sanitary attributes of seed, such as the germination rate and the presence of disease, stones, sand, broken seed, or weed seed). Quality is a genetic and physical component of seed security.

Seed accessibility concerns whether farmers have the means to acquire good quality seed. How they acquire seed can be economic (via purchase, barter, or credit) or social (via the gift economy/mutual aid). Accessibility is a socio-economic component of seed security.

While availability, quality, and accessibility are the three core components of seed security, seed *in*security needs to be understood in terms of chronic and acute stress.

- Acute seed insecurity occurs due to distinct and transitory events that impact farmers' access to good quality seed. Drought, flood, cyclones, and social upheaval can all be causes of acute seed insecurity. Acute seed insecurity can negatively impact a wide range of farmers, even those who are relatively well-off in their communities.
- Chronic seed insecurity occurs among marginalized peoples. The marginalization of farmers can be economic, like when agricultural production is valued/priced so low that farmers remain in a poverty trap. Marginalization could also be ecological, like when farmers occupy marginalized lands or when climate change negatively impacts their production. Marginalization can also be political, like when farmers live in zones of long-term conflict or under exploitative land tenure systems.

Acute and chronic seed insecurity are not always conceptually distinct. For example, the regularly occurring cyclones in southeast Madagascar contribute to a seed insecurity that is neither wholly acute nor chronic. A cyclone is an acute stress as it produces one-time damage to agricultural production, but cyclones can be a chronic stress when reoccurring. Also, acute shocks can occur in zones that already face chronic seed insecurity, e.g., when chronically poor

farmers are hit by a drought. Thus, an SSSA conceptualizes seed insecurity in terms of acute and chronic stress while simultaneously acknowledging that these concepts can blur into each other.

Seed System Security Assessment (SSSA)

A farmer has seed security when all three components (availability, quality, accessibility) are adequately attained. In most cases of seed *in*security, one or maybe two of these components of seed security are not realized. Only in rare cases are all three components problematic. Thus, one core purpose of the SSSA is to identify whether farmers face issues with availability, quality, or accessibility. From this analytical base, the SSSA can diagnose the nature of seed insecurity and generate appropriate and actionable recommendations for actors in the seed system. The SSSA generates recommendations tailored to seed security's core components.

Table 2: Seed system problems and broadly appropriate responses

Constraint on seed security	Short-term response	Longer-term response
Availability	Direct distribution of seed	Support development of seed production, including commercial enterprises where viable
Seed Health/Quality	Distribution of healthy or treated seed	Programs to address production or storage constraints (e.g., to reduce postharvest deterioration)
Varietal Quality	Distribution (through direct seed distribution (DSD) or seed vouchers and fairs of varieties specifically adapted, which can tolerate stress	Participatory plant breeding to identify adapted and acceptable varieties
Access	Cash disbursement Seed fairs with vouchers or cash Local procurement and distribution	Poverty-reduction programs, e.g., support for the development of agro-enterprises and other ways to generate income

Source: When Disaster Strikes seedsystems.org

The goal of an SSSA is ultimately to produce recommendations that strengthen the resilience of the seed system and improve smallholder farmers' access to good quality seed. In a resilient seed system, farmers are not in a state of chronic seed insecurity, and they are able to maintain their seed security even after acute shocks. Farmers can procure new varieties in a resilient seed system that responds to changing environments. A resilient seed system is supported by national research institutes that produce and multiply new varieties. Resilient seed systems are self-reliant and market-driven and generally do not rely on development interventions.

Source: Sperling, 2023

Box 1. Characteristics of a resilient seed system

1. Stress-tolerant crops and varieties that are adapted to the agro-ecological context have been identified by national seed structures and accepted by the farmers.
2. A diverse selection of these stress-tolerant crops and varieties has been curated, allowing farmers to shift their planting strategies in response to changing environmental conditions.
3. The production/multiplication of stress-tolerant varieties has been increased, ensuring availability to farmers.
4. Delivery mechanisms using multiple channels ensure stress-tolerant crops and varieties traverse the last-mile and are made available to remote farmers.
5. Affordable (small) packaging sizes are available, enabling low-income farmers to purchase certified seeds.
6. Climate and market information systems are developed and widely broadcast, enabling poor farmers to effectively respond to variable conditions.

III. METHODOLOGY

Survey Tools and Sample Sizes

The SSSA analyzes how a seed system functions, where it is faltering, and how it can be sustainably strengthened. This analysis is accomplished via quantitative interviews with farmers and qualitative interviews with actors in the seed sector, including seed producers, seed traders, agro-enterprises, grain dealers at the local market, government actors, and NGOs. The quantitative surveys with the farmers gather information on the demand for seed, and the qualitative and quantitative interviews with the seed sector actors gather information on the supply of seed. This supply- and -demand approach enables the SSSA actors to highlight the constraints on seed security regarding the fundamental logic of supply and demand.

Table 3: Investigative methods used in this SSSA

Type of Investigation	Number of Interviews
Background information	--
Government agents	10
NGOs	5
Agro-enterprises	4
Agro-processors	2
Large seed/grain traders	3
Seed/grain market traders	25
Seed producers	15
Household interviews	659
Community focus groups	8
Women's focus groups	8

Site Selection

ADRA selected the sites of the SSSA. Target sites for this investigation were based on the following criteria:

1. Participation in ARISE II: The SSSA targeted ARISE II districts and communes. All four communes participated in ADRA's agricultural program that included seed distributions.
2. Agro-ecologically representative: The districts and communes were representative of the agro-ecological characteristics of the region.
3. Isolation and vulnerability: ADRA selected remote communes far from district capitals. Isolated rural areas are typically more vulnerable to shocks and stresses because they are farther from government and agribusiness services, hindering seed access.
4. Geographic coverage: Ambalatany is located in the western corner of Atsimo Atsinanana, and Manambondro is in the eastern corner. Mahafasa and Lopary are dispersed within the region.
5. Logistical feasibility: Ambalatany, Manambondro, Mahafasa, and Lopary have the necessary infrastructure and ADRA contacts to facilitate the reception of the SSSA investigators. Each of the 4 SSSA investigation teams consisted of 10–12 members.

Table 4: Sites of the SSSA

District	Commune	Fokontany
Farafangana	Ambalatany	Ambalamanga, Ambalatany, Bemitsanga, Mahamanina, Mahatsinjo, Matsakaria, Vohidahy, Vohitrarivo
	Mahafasa	Anandaza, Magnatsa, Mahafasa, Manatsaha, Vohitraomby
Vangaindrano	Manambondro	Ambaniampy, Ambato-mahavelo, Ambatovanda, Kidilanitra, Mahabe, Mahatsinjo Riaky, Manambondra, Maromena, Vohindava
	Lopary	Besakay, Betsiraha, Iabomora, Lopary, Mahabe, Mahazoarivo, Maroangaty, Marolambo, Morafeno, Soarano, Soatsirana

Within these sites, each type of stakeholder was selected using tailored criteria and methodologies:

- Household survey: these respondents were selected randomly. Starting in the center of the village, each surveyor moved outward (like the spokes of a wheel), selecting every third household for an interview. The 659 farmers who responded to the household interview were from 156 villages, 34 fokantany, four communes, and two districts.
- Community focus group: ADRA field agents in the target communes asked community leaders to mobilize 30–50 people (men and women) for this mixed focus group discussion. The 134 farmers (62 men and 72 women) participating in these four focus groups were from four villages in the four target communes.
- Women's focus group: ADRA field agents in the target communes asked community leaders to mobilize 20–30 women for this focus group discussion. The 122 female farmers participating in these four focus groups were from the same four villages as the focus group discussions (one village per target commune). None of the women from the community focus group discussions participated in the women's focus group discussions.
- Government personnel: at least one respondent was interviewed in the four communes. They were often interviewed first to identify other important actors in the local seed system. The government personnel representatives included district and commune level government and government agents at the Official Seed and Plant Material Control Service (SOC), who ensure the quality of certified seed.
- Seed producers: the survey team interviewed all the seed producers that could be found in the 2 target districts.
- Agro-enterprises: the survey team struggled to find agro-enterprises. They found and interviewed four in the two target Districts.
- Large seed/grain traders: the survey team could not find large seed/grain traders, so they interviewed small seed/grain traders.
- NGOs: the survey team relied on ADRA project staff to identify NGOs that operate in the seed system in the two target districts.
- Seed/grain market traders: the survey team found a variety of seed/grain traders in the local markets. Some of them sold seed/grain out of a permanent shop. Others sold seed/grain from a stall at the weekly market. At least six seed/grain traders were surveyed in each of the four communes.

The preliminary findings and recommendations were vetted with local stakeholders such as: Agents of the local Official Seed and Plant Material Control Service (SOC), representatives from Catholic Relief Services in Farafangana, ADRA surveyors and Ministry of Agriculture selected team supervisors. This provided the team with local feedback on the findings and recommendations.

Respondent Demographics

The goal of the SSSA is ultimately to produce recommendations that strengthen the seed system and improve smallholder farmers' access to good quality seed. Understanding the farmers' perspectives and vulnerabilities is a priority for the SSSA. Thus, the SSSA focuses most of its surveyor labor on the household survey of the farmers.

Table 5 encapsulates the demographic characteristics of the randomly selected households. High rates of rural emigration (particularly among the men) explain why nearly half of the households were led by women. Also, over half of the households cultivated less than one hectare.

Table 5: Household characteristics

Feature	Description	% Sample
Type of HH	Adult headed Child headed Grandparent headed	90 1 9
Sex of HH head	Male Female	53 47
Average age of HH head	43	
Average size of HH	7	
Migration Status	Resident Displaced	96 4
Area Cultivated	< 0.5 ha 0.5 – 1 ha 1 – 2 ha > 2 ha	27 36 27 10

Limitations

The SSSA is focused on the resilience of the farmers' seed systems. Food production and consumption in rural Madagascar is organized at the household level. In other words, the rural household is the fundamental production and consumption unit. The majority of crop production in rural Madagascar takes place on household collective plots. The collective plot system is a form of risk pooling that ensures that the household's limited labor and resources are focused on growing sufficient quantities of the household's principal crops. In a subsistence agricultural system, a household's principal crops are those that ensure food security and are resilient to the shocks and stresses that characterize the agro-ecological system. In sum, the main objective of this social organization of food production is to ensure the household's resilience/food security.

Thus, to produce knowledge about the resilience of the farmers' seed systems, the SSSA's individual survey focuses on the *household's principal crops*. The respondents answered questions about the three main crops their household planted last year and the three main crops they will plant next year. However, this methodology inevitably underrepresents the less important crops and crops more likely to be cultivated in individual fields. As a result, the "household level" data emerging from the individual survey underrepresents the fourth, fifth, and sixth important crops. This explains the "top-heavy" data in Table 16, in which the 659 farmers planted 19,532 kilograms of rice seed but only 178 kilograms of beans. The quantitative and qualitative interviews with seed producers, agro-processors, and market vendors correct this issue.

The SSSA has a rigorous methodology for converting seed weights from the farmers' local measurements (cups, buckets, etc.) into kilograms of seed. However, the farmers use vines and cuttings (i.e., planting materials) to plant cassava, sweet potato, and yams. The SSSA has another methodology for converting bundles of planting materials into kilograms. This conversion is challenging in Atsimo Atsinanana because the weight of a bundle of planting materials is not standardized. The weight of these bundles depends on how much a farmer can carry. For example, a man and a woman could independently report that they planted three bundles of cassava, but the man may have planted twice as many kilograms of cassava because he can carry larger bundles. As a result, the surveyors asked the farmers to estimate the weight of their bundles of planting materials. If the farmer did not know this weight, the surveyor used a standardized conversion rate (see Table 6). These quantities represent the average weights of bundles of planting materials for each of the crops. These average weights are an approximation.

Table 6: Conversion rates of planting materials to kilograms

Crop	Cuttings / Kg	Cuttings / Bundle
Cassava	40	240
Sweet Potato	67	670
Yam	67	670

The SSSA synthesizes data from numerous crops under a unified analytical framework. However, the farmers use vines and cuttings (planting materials) to plant cassava, sweet potato, and yams, and they use seed to plant the rest of the crops (rice, beans, bambara nuts, corn, etc.) The SSSA must convert the weight of planting materials to its analogous "seed weight" so that seed and planting materials can be comparable. Thus, converting the weight of planting materials into its comparable "seed weight" is an approximation of an approximation. As a result, the total quantities of cassava and sweet potato planted are a little low in relation to the total quantity of rice seeds planted (see Table 16 below).

IV. THE AGRO-ECOLOGICAL, SOCIAL, AND LEGAL CONTEXT

The Agro-Ecological Context

Atsimo Atsinanana is in the hot and humid agroecological zone in southeast Madagascar. The average annual rainfall is 3,700 millimeters, making it one of the lushest zones in Madagascar. However, agricultural production remains low, and farmers struggle with the rising variability in rainfall patterns and the increase in extreme weather events that result from climate change. Farmers in this zone grow rice, cassava, and sweet potato to meet their subsistence needs. Almost all rural households cultivate rice, and they consume over 70% of their production. Cassava and sweet potato are also staple crops that are crucial to a household's food security. Farmers grow a large variety of other crops (yams, beans, bambara nuts, corn, peanuts, bananas, breadfruit, jackfruit, litchi, cloves, and coffee) for sale and some home consumption. They employ dryland and irrigated agricultural practices on small and dispersed fields. The farmers irrigate their rice fields by terracing the low points of watersheds, leveling the fields, controlling the water levels with small canals or sluices, and flooding the fields. The water levels in these fields are maintained to optimize rice production.

Poor farmers have access to small parcels of arable land and insecure land tenure. They often rely on hillside slash-and-burn (swidden) agriculture due to a lack of access to soil amendments and insecure land tenure.[i] Poor households rely more on cassava and sweet potato production and less on rice production because they have less access to irrigated rice fields, and cassava and sweet potato are less vulnerable to cyclones and flooding.[ii] Meanwhile, the relatively wealthy farmers in this zone have access to larger plots of arable land and animal traction; they also raise more cattle and pigs.

Atsimo Atsinanana is a volatile ecological system (see Table 7). Madagascar was struck by 35 cyclones between 1996 and 2016, tripling the number of cyclones that struck the country between 1976 and 1996.[iii] Tropical Cyclone Freddy struck Atsimo Atsinanana in February of 2023 with major flooding and winds up to 180 kilometers per hour. In 2022, Tropical Cyclones Batsirai and Emnati hit southeast Madagascar, negatively affecting 420,000 people.[iv] These cyclones flood entire villages and destroy crops, homes, local businesses, hospitals, and schools. These extreme climatic events routinely threaten agricultural production in Atsimo Atsinanana.

In the women's focus group discussions, the participants said that they have responded to shocks and stresses via a number of resilience strategies. They diversify crops and seek new varieties to adapt to the changing climate. They engage in fishing, hunting, and gathering to supplement their income. Vulnerable households also deploy various coping mechanisms. They reduce unnecessary expenses and the number of daily meals, and they rely more on cassava and less rice because cassava is cheaper and a more resilient crop.

"*In times of stress, we reduce the production of long-cycle crops in favor of short-cycle crops, which allows us to generate more income and have more time to devote to crafts and fishing*." — women in a focus group discussion; Lopary, Vangaindrano, July 2023

In the four community focus group discussions, the farmers evaluated the harvest of their most important crops over the last three years. Despite some variability, the surveyors were able to synthesize their findings across the four communes. The farmers indicated that last year's main rainy season was generally a good year for cassava and sweet potato, enabling them to recover from the previous year when all three of their principal crops had a poor harvest.

Table 7: Community assessment of crop performance over the past three years

Principal Crop	2022-2023	2021-2022	2020-2021
Rice	Weak – Cyclones, Floods	Weak – Cyclones, Floods	Weak – Drought
Cassava	Good	Weak – Cyclones	Weak – Lack of Seed
Sweet Potato	Good	Weak - Lack of Seed	Good

In focus group discussions, male and female farmers listed their main production concerns with their three principal crops. The lack of land and theft were some of their primary concerns. They also discussed labor constraints and poor soil fertility.

Table 8: Main concerns with production

Crop	Main Problems
Rice	• Lack of land to cultivate • Lack of labor • Low yields and exhausted soils • Lack of money for quality seed varieties adapted to local agro-ecological context • Shortage of agricultural inputs, particularly fertilizers • Exhaust grain supplies before planting season; consume the grain set aside for seeds • Rats eat the grain in the field and their granaries • Theft
Cassava	• Due to increasing rates of theft, farmers harvest cassava too early. Harvesting before full maturation results in depressed yields and immature stems. The immature stems reduce germination rates and yield potential in the following season. • Stems dry out during storage
Sweet Potato	• Exhausted soils • Lack of land • Theft

Although the farmers did mention problems with damage from rats, none of the farmers mentioned problems with disease issues in the focus group discussions. However, their three main crops are attacked by several diseases. For example, the Mosaic virus is particularly problematic for cassava production in the region. Other diseases negatively impacting cassava production in the region include Anthracnose and Cassava brown streak.[v]

Good quality seed is an essential component of a farmer's production, but it is only one component. Soil fertility, timely weeding, pest management, and consistent rainfall are also necessary components of good yields. As a result, the quality of the seed did not necessarily align with the size of the yield.

Table 9: The relation between seed quality and harvest quality

Crop	Good Quality Seed Produces Good Yield		Average Quality Seed Produces Average Yield		Poor Quality Seed Produces Poor Yield		Yield Aligns with Seed Quality	
	N	%	N	%	N	%	N	%
Rice	388	35%	167	72%	80	61%	635	48%
Cassava	311	53%	140	78%	40	48%	491	60%
Sweet Potato	351	63%	140	79%	30	57%	521	68%
Beans	21	71%	16	56%	7	29%	44	59%
Bambara Nuts	22	77%	18	83%	3	100%	43	81%
Yams	48	71%	18	78%	4	50%	70	71%
Total								59%

The Social Context of Agricultural Production

Atsimo Atsinanana is the second poorest region in Madagascar — 83% of the population is below the poverty line ($240/year).[vi] Rural areas of the Atsimo Atsinanana region have elevated levels of food insecurity because the farmers are generally poor and have low resilience to reoccurring cyclones and their associated flooding.[vii] The region is also hit by an occasional drought.[viii] Because of the difficulty associated with rural livelihoods, emigration from rural areas is high, especially among men; this explains why 47% of the households are female-headed households.

Despite these challenges, Atsimo Atsinanana has high agricultural potential. The farmers are already growing a large diversity of crops (see Tables 10 and 11). However, they currently add very little value to their harvested crops via local processing. Increasing agricultural production and value addition could decrease food insecurity and rural flight, revitalizing rural communities.

Table 10: Farmers' Purpose for Their Diversity of Crop Production

Crops	Importance for consumption	Importance for income	Processing
Rice	High	Low	Decortication
Cassava	High	Medium	None
Sweet Potato	High	Medium	None
Yam	High	Low	None
Taro	High	Low	None
Breadfruit	High	Low	None
Beans	Low	High	None
Bambara Nuts	Low	High	None
Maize	High	Low	None
Cowpea	Low	High	None
Peanut	Low	High	None
Sesame	High	Low	None
Chinese Cabbage	Medium	High	None
Cabbage	Medium	High	None
Bok Choi	Low	High	None
Eggplant	Low	High	None
Zucchini	Low	High	None
Cucumber	Low	High	None
Chive	Low	High	None
Bitter Eggplant	Medium	High	None
Banana	Medium	Medium	None
Clove	Low	High	None
Vanilla	Low	High	None
Sugar Cane	Low	High	Alcohol

In the household survey, the respondents provided information on their three most important crops for the last main rainy season and the next (see Table 11). Rice, sweet potato, and cassava were by far the most important crops.

Table 11: Percentage of Farmers Growing Each Crop for Last Season and Next Season

Crop	Last Season		Next Season	
	Vangaindrano	Farafangana	Vangaindrano	Farafangana
Rice	98%	93%	99%	95%
Sweet potato	91%	71%	89%	68%
Cassava	88%	65%	87%	66%
Yam	2%	17%	2%	17%
Bambara nuts	2%	10%	4%	15%
Beans	3%	9%	3%	12%
Taro	0%	3%	0%	3%
Corn	0%	2%	1%	3%
Bok choy	0%	2%	0%	2%
Cowpea	0%	1%	0%	1%

Almost all the farmers in Atsimo Atsinanana produced rice. Access to land appears to play a role in rice production; over half of the households that did not grow rice in the 2022–2023 season farmed less than a half hectare (see Table 12).

Table 12: Access to land in relation to rice cultivation

Area Cultivated	Households not growing rice (N=28)	Households growing rice (N=631)
< 0.5 ha	52%	26%
0.5 – 1 ha	17%	37%
1 – 2 ha	24%	27%
> 2 ha	7%	10%

However, access to land does not appear to play a role in a household's decision to grow sweet potato or cassava. For example, roughly a quarter of households that grow sweet potato and a quarter of households that don't grow sweet potato farmer less than a half hectare.

Table 13: Access to land in relation to sweet potato and cassava cultivation

Area Cultivated	Households not growing sweet potato (N=129)	Households growing sweet potato (N=530)	Households not growing Manioc (N=163)	Households growing Manioc (N=496)
< 0.5 ha	24%	27%	28%	26%
0.5 – 1 ha	32%	38%	35%	37%
1 – 2 ha	31%	26%	27%	27%
> 2 ha	13%	9%	10%	10%

Gender

"*As women, it has been difficult for us to practice agriculture, especially for our staple crops such as cassava, sweet potato, and rice, which require considerable labor. In addition, we are faced with a lack of access to arable land*." — Women in a focus group discussion in Lopary, Vangaindrano.

The barriers to inclusive participation in agriculture are social. Women in the focus group discussions said they must find ways to take control of their lives and make decisions over their livelihoods. But they face a number of barriers. For example, according to traditional norms, rural women in Atsimo Atsinanana do not have the right to inherit property, including arable land. Women rarely acquire official rights to land, and when they do, it is often a small plot. In the focus groups, women often said that the land allocated to them is woefully small compared to what men control. Women also face significant barriers to accessing credit because they often lack collateral. Older women who have an adult son have more access to credit because the adult son will often provide collateral for their loans. Younger women (and older women without a willing son) often access credit via local money lenders who charge high interest rates — 50% is not an unusual interest rate in these cases.

Male-Headed Households

Agricultural production is organized at the household level, and rural households in Atsimo Atsinanana are generally patriarchal by default. An older man is the household head and controls the household's collective plot (unless all the men in the household have emigrated or died.) The main staple crops (rice, cassava, and sweet potato) are grown on these collective household plots. The male head of household controls the production and harvest of the collective plot. He decides what crops to grow, what varieties to plant, the production practices, when to harvest, how to store the crop, how much of the harvest they will sell, and how to spend that income. Women can express their opinions to the male head on all these matters, but he is the one who makes the final decision. In general, men control the household's financial resources, and women manage household affairs. Women often oversee the family's daily expenses, but their expenditures and decisions are subject to a man's oversight. Despite the women's structural disadvantages, they are active in a diverse set of livelihood activities. Women actively participate in the harvest, barter, and sale of agricultural products, and it is generally women who sell the household produce in the market.

Everyone of working age in the household is expected to work in these collective plots. In an unmechanized and undercapitalized subsistence household, agricultural intensification means increasing labor inputs. Thus, agricultural intensification often occurs via male heads compelling subordinates in the household (women, junior males, children) to work harder.

> *Agricultural intensification is about getting people to work harder, a process that is social and gendered (getting some people to work harder than others) and that is typically coercive and conflictual. The manner in which labor intensification is negotiated and struggled over — that is to say, how agricultural played through the determinate rules of access to and control over resources — fundamentally shapes the character and the trajectory of agrarian change itself.*[ix]

In male-headed households, women have more power over the crops that are traditionally associated with women. In focus groups, women stated that market gardening is the women's affair, and it is their best means of generating income. Market garden crops include Chinese cabbage, cabbage, bok choy, eggplants, zucchini, cucumber, and tomatoes. The production of these crops is broadly considered as 'women's work' because they require less physical strength, although hauling water and manure and digging raised and sunken beds in the gardens is still physically demanding. Women said that growing these vegetables is valuable work because they grow well in their region, many have a short production cycle, and they are easy to sell.

Female-Headed Households

According to individual surveys, almost half of the households are headed by women. Some respondents said that men go to the cities because it is difficult to build wealth with agricultural production alone, given the variable climatic conditions in Atsimo Atsinanana. So, the men emigrate to cities to generate wealth that they can bring back to the village and invest in their homestead and agricultural production. However, some women (in the women-only focus groups) said that female-headed households are prevalent because of men's reluctance to take on family responsibilities, and community development should focus on finding ways for women to earn a living, especially those without land or capital. Independent of the reasons behind male

emigration, the respondents all agree that many women are left in the village to manage households by themselves, and the absent men can still exert some control of these female-headed households. Men living in a nearby city can maintain the right to make major decisions within the rural household. Men can also maintain the right to control any surplus generated by the household that they departed. Thus, female-headed households are complex arrangements where a woman makes all the daily production and consumption decisions to maintain an agricultural household. Many of these women are still subject to oversight from an absent man, but that oversight can be difficult to impose from far away.

A quantitative analysis of the individual survey data revealed that the female-headed households have remarkably similar agricultural practices to the male-headed households in many respects.

Table 14: Examples where the difference between male- and female-headed households is LESS than 10%

Activity	**Female-headed households**	**Male-headed households**
Rice is one of the three most important crops	95%	97%
Sweet potato is one of the three most important crops	77%	73%
Percentage of seed sourced from own stock last year	32%	39%
Use fertilizer	4%	4%
Use pesticides	23%	31%
Apply organic soil amendments	60%	67%
Uses storage chemicals	11%	16%
Have storage losses	11%	13%
Received a new variety in the last five years	44%	50%

Nevertheless, female-headed households did seem to diverge from male-headed households in a few key areas. Female-headed households were more likely to have less land, more likely to plant less because they couldn't afford seed, more likely to prioritize rice production, and less likely to prioritize cassava production (see Table 15). The logical explanation is that men are more likely to emigrate to cities in search of other sources of income when the household owns a small plot of land that does not provide a secure agricultural livelihood. As a result, women-headed households often have less arable land. Therefore, they use their limited resources to intensify rice production to boost yields. In women's focus groups, the participants said that widowed, separated, and single mothers are particularly vulnerable, and they often struggle to find enough food to feed their families. They often resort to obtaining food on credit from village shops, and they can get trapped in debt.

Table 15: Examples where the difference between male and female-headed households is GREATER than 10%

Activity	Female-headed households	Male-headed households
Cultivate less than half a hectare	34%	20%
Not enough money to buy seed is the reason for planting less last year	44%	33%
Cassava is one of the three most important crops	69%	80%
Households using organic soil amendments apply it to rice	40%	26%
Households using organic soil amendments apply it to cassava	17%	27%
Storage chemical users apply to rice	100%	69%
Storage chemical users apply to cassava	0%	16%
Storage chemical users apply to sweet potato	0%	14%

The Legal Context

For a long time, only certified seed was officially recognized as seed in Madagascar. The Malagasy government's SOC was established in 1995 (by Law #94-038) to monitor, control, and certify rigorously produced seed and planting materials.[x]

Malagasy seed regulations were significantly revised in 2010 — the biggest change was the government's official recognition of QDS. QDS was established in Madagascar by the Food and Agriculture Organization of the United Nations (FAO) and the Centre Technique Agro-écologique du Sud (CTAS). They introduced QDS to southern Madagascar, and the survey team found no evidence of QDS in Atsimo Atsinanana. Foibe Fikarohana momba ny Fampandrosoana ny Ambanivohitra (FoFIFA) conducted the distinctness, uniformity, and stability tests for QDS and submitted the seed to the SOC for evaluation. QDS has been registered by the Comité Consultatif Régional d'Inscription au Catalogue. CTAS has managed the packaging and labeling of QDS.[xi] The control process for seed to become QDS includes laboratory testing of the seed, on-farm inspections of seed production, quality assurance mechanisms (e.g., sanctions for substandard seeds and possible expulsion of producers from the QDS program), and traceability to verify the origin of QDS. QDS initiatives aim to increase the production of high-quality seeds, make quality seed more affordable, and minimize the risk to the farmers purchasing the seed. QDS must meet specific standards of quality that include seed purity, germination rates, physical seed quality, and freedom from diseases and contaminants. The QDS classification enables NGOs, farmer associations, and industrious farmers to legally produce quality-controlled seed without the more expensive seed monitoring and control process of the SOC.

Although Malagasy seed laws officially acknowledge QDS, it remains an under-exploited opportunity in the country. The next section will discuss the seed producers that the SSSA team found in Atsimo Atsinanana. The vast majority are informal seed producers who carefully control the quality of their own seed to ensure repeat business that a good reputation affords. However, these informal seed producers did not certify their seed with the SOC or undergo the independent control mechanisms that constitute QDS.

V. THE SEED SYSTEM IN ATSIMO ATSINANANA

Farmers procure seeds and planting materials via formal and informal seed systems. They use a variety of sources to procure seeds. They save their own stock. They exchange seed with neighbors. They buy seed in the local market. They take out seed loans from local seed producers. They receive free seed via NGO distributions. This diversity of seed procurement strategies is the main source of resilience in their seed system. Thus, this section will analyze the farmers' current demand for seed and acute stressors via their current crop profiles, the quantities of seed they sow, and their diverse seed procurement strategies. After discussing the current seed system, this section will then go beyond the near-term seed system and analyze the medium-term trends, such as emerging opportunities and sources of chronic seed insecurity.

How and Where Farmers Obtained Seed Last Season

Table 16 shows the total kilograms of seed that the 659 households planted, according to the individual survey that questioned one of its members about their three major crops last year. The most striking finding is that farmers get over 99% of their seed and planting materials from the informal seed system (saved stock, their social network, and the local market.) Last year, the farmers procured seed almost entirely from the informal seed system. The farmers did not seem to buy any certified seed from agro-dealers or receive any seed via government distributions. Interviews with other actors in the local seed system said that the government is an important source of seed distribution, even if the farmers surveyed did not receive seed from the government last year. Other actors in the seed system also stated that the agro-dealers generally do not supply seed to the farmers because the demand for certified seed is extremely low. Agro-dealers do not sell certified seed for the most important crops because the farmers are unwilling to pay the higher cost. Thus, the lack of agro-dealers is a demand problem, not a supply problem. However, agro-dealers did sell small packets of certified horticultural seed, and there was some demand among the farmers for this seed.

Table 16: Total kilograms of seed planted in the 2022-2023 season & their source by percentage

Crop	Kilograms Planted	Saved Stocks	Friends, Family, Neighbors	Local Market (Informal)	Agro-dealers (Formal)	Government	NGOs
Rice	19532	37	21	42	0	0	0
Sweet Potato	311	55	19	25	0	0	1
Cassava	303	38	44	18	0	0	0
Beans	178	7	5	86	0	0	3
Bambara nuts	148	17	5	78	0	0	0
Corn	15	0	67	33	0	0	0
Bok choi	10	0	0	100	0	0	0
Peanuts	6	0	0	100	0	0	0
Cowpea	5	0	0	100	0	0	0
Eggplant	5	60	0	40	0	0	0
Sesame	2	0	0	100	0	0	0
Yams	1	32	10	52	0	0	6
Taro	0	13	12	75	0	0	0
TOTAL	20516	37	21	42	0	0	0

Figure 2 (below) is a graph of the same information, but it focuses on key findings and displays the general tendencies in a more visible format. Figure 2 shows that farmers rely on the market much more for bambara nuts and bean seed. Rice, sweet potato, and cassava are the most important crops for the farmers' consumption/food security, and their seed sources for these crops are evenly distributed among the informal systems. This diversity of seed sources mitigates risk. If any of these sources fails in a given year, the farmers have two other reliable sources from which they acquire significant amounts of seed. Also, it is worth noting that their saved stock is their main source of sweet potato planting materials, and their social network is their main source of cassava planting materials.

Figure 2: Where farmers acquired seed — percentage of seed planted in the 2022–023 season from each source

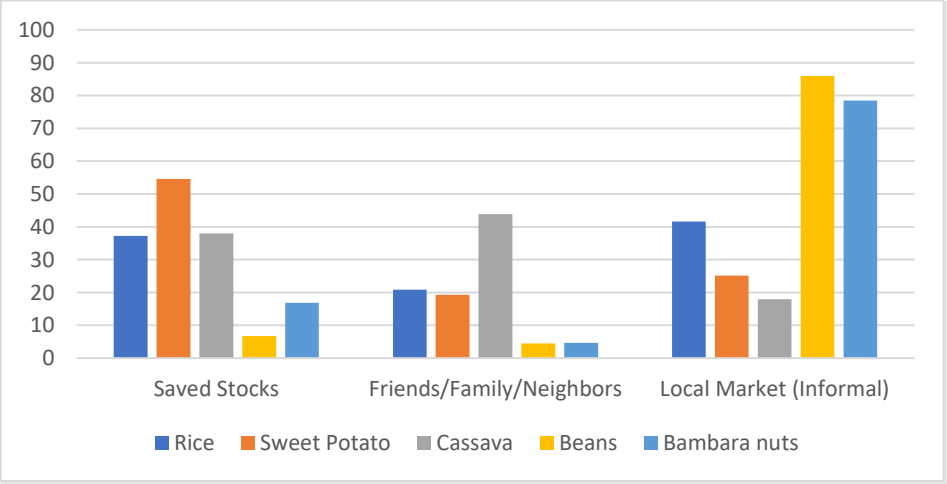
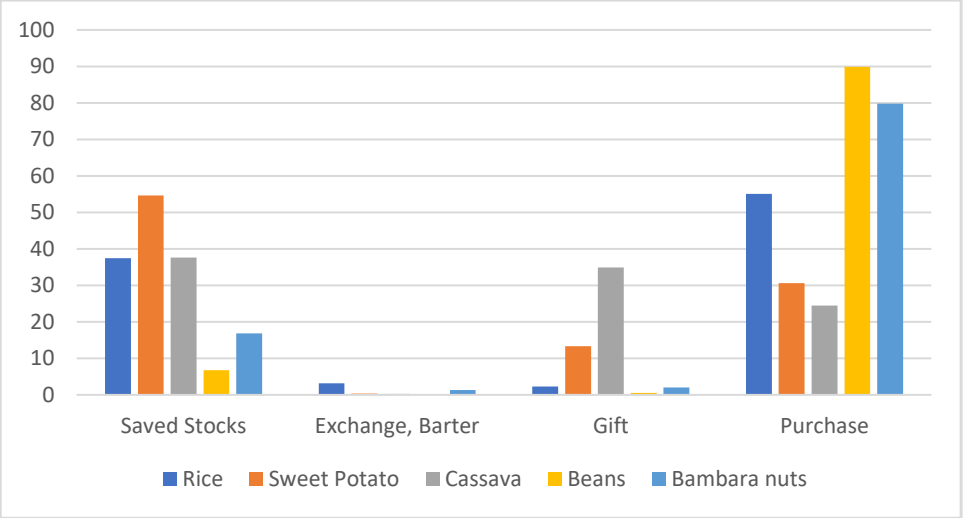


Figure 3 (below) is slightly different in that it shows *how* the farmers acquired their seed from these various sources. The most interesting finding is the importance of gifts and mutual aid in cassava and sweet potato seed. Farmers acquired roughly 20% of their rice seed from their friends, family, and neighbors, but nearly all the rice seed acquired from their social network was bought and sold. Farmers also acquired 20% of their sweet potato planting materials from their social network, but half was given as a gift. Meanwhile, farmers acquired over 40% of their cassava planting material from their social network, *most of which* was given as a gift. Thus, farmers buy rice seed from their social networks, but they exchange large amounts of sweet potato and cassava cuttings within reciprocal systems of mutual aid.

Figure 3: How farmers acquired seed — percentage of seed planted in the 2022–2023 season via each transaction mechanism



According to actors in the seed system, sweet potato and cassava cuttings are exchanged within a gift economy because sweet potato and cassava are more important to a household's resilience and food security. Seed security is higher for cassava and sweet potato because these crops are more resistant to cyclones and the accompanying flooding. According to respondents, when a cyclone hits, the concomitant flooding can wipe out a farmer's rice fields. Although rice fields are intentionally flooded, excessive flooding can cause submergence stress, suffocation, physical damage, and additional disease pressures for the rice plants. When rice fields are damaged, a household's most pressing concern is how they will feed their family this year, and they often consume the rest of their saved stock. Acquiring rice seed for next year's agricultural campaign is tomorrow's problem. And when tomorrow comes, they can exchange work or their future harvest for seed. According to respondents, that same cyclone could leave the cassava harvest unaffected because the edible tubers are underground on hillsides, protected from the flood waters and harsh winds of cyclones. However, the heavy winds from the cyclone can damage cassava stalks and decrease the amount of available planting material the following year. When this happens, farmers and middlemen travel up to the plateau to zones unaffected by the cyclone, buy planting materials, and transport them back to Atsimo Atsinanana. The state agricultural agent in Vangaindrano said that the supply of cassava cutting can take a few years to bounce back to 'normal' levels after bad cyclones with high winds. However, that same cyclone with terrible winds that wipes out rice fields and damages cassava stalks often leave sweet potato

production unaffected because sweet potato plants are vines creeping along the hillside ground, and the sweet potato harvest is underground on hillsides that do not flood easily. According to respondents, sweet potato production is more resilient to cyclones than cassava production, and cassava production is more resilient to cyclones than rice production. However, this is only a general tendency. Flooding on more level fields can still damage cassava and sweet potato tubers as stagnant water increases disease pressure on the tubers. The timing of the floods also determines the level of damage to cassava and sweet potato; if the tubers have not yet formed, floods cause less damage. Actors in the seed system claimed that cassava and sweet potato seed can be exchanged within the gift economy because it is the stable source of food for vulnerable households, especially after they are hit by these frequently occurring cyclones. However, cassava planting materials are bulky and can be hard to transport to market, and (unlike rice seed) planting materials cannot be eaten; this also explains why so many cassava planting materials are given as a gift.

Seed Insecurity in Atsimo Atsinanana

Farmers in Atsimo Atsinanana occupy a precarious position in a volatile climate, and their access to seed is highly sensitive to this volatility. The farmers claimed that cyclones are occurring with greater frequency, and their seed security is decreasing as a result.

In the women's and mixed focus group discussions, farmers were asked to estimate the percentage of households in their community that are seed insecure. Before asking the question, the facilitators defined seed security as follows: "Seed security means that a household has the seed it needs (via saved stocks) or can get the seed it needs, for example, through purchase or barter. In this community, what proportion of households would be considered SEED SECURE — that is, they already have enough seed or can get it."

Table 17: Farmers' estimation of seed security in their communities

Crop	Percentage of households who were seed secure last season	
	Women's Focus Groups (n=4)	Mixed Focus Groups (n=4)
Rice	18%	41%
Cassava	34%	77%
Sweet Potato	41%	75%

The female farmers appeared to believe that much higher rates of seed insecurity exist in their communities (see Table 17). It is quite possible that women-headed households have higher seed insecurity, and they were given more opportunities to make their voices heard in the women's focus groups. As discussed above, women-headed households generally have less access to land, smaller harvests, smaller quantities of saved stocks, and, therefore, less seed security. The size of the household's arable land appeared as the main barrier to seed security among women-headed households. None of the respondents indicated that women have a harder time accessing seed loans (*bongary*) or reciprocal gift exchanges of cassava and sweet potato planting materials.

Another potential explanation for the women's focus groups indicating higher levels of seed insecurity in their communities is that the women were exaggerating a crisis or telling NGOs what they want to hear can bring more attention from aid. For example, the ARISE II team

members were not directly involved in the focus group discussions, but they did mobilize the farmers to attend the focus groups. The farmers recently received a distribution of bambara nuts from the ARISE II project. The farmers in these mixed focus groups insisted that their three most important crops were rice, cassava, and bambara nuts. However, the ARISE II team members did not mobilize the farmers for the individual surveys, and the individual survey data shows that only 3% of the farmers listed bambara nuts as one of their three most important crops last season. Thus, there is some evidence that the farmers were capable of adjusting their responses according to the audience.[xii] Nevertheless, despite the inconsistency in estimating seed insecurity in their communities, the women's and mixed focus groups consistently claimed that seed security was lower for rice than cassava and sweet potato. As discussed above, these results also indicate that the respondents tend to see cassava and sweet potato as more stable production sources.

Table 18: How seed-insecure farmers procure seed

Crop	Strategy
Rice	• Bongary: farmers are given a seed loan at planting time, and after the harvest, they repay the loan with twice as much grain • Farmers exchange their labor (typically in another's fields) for seed • Exchange of crops (for example: 1 can of rice for 5 kg of cassava)
Cassava	• Neighbors/friends/family provide planting materials for free. • Farmers exchange their labor (typically in another's fields) for stems
Sweet Potato	• Farmer asks friends/family/neighbors to give five vines each. • Farmers exchange their labor (typically in another's fields) for vines

The data indicated that the farmers increasingly rely on seed loans and seed exchange with the seed producers. One of the informal seed producers shared: "Production has experienced a decline over the last five years. Climate change, cyclones, and drought are the main factors behind the decline in agricultural harvests across the district. The lack of labor, degradation of seeds, and lack of financial resources have also contributed to the problem. And so, residents do not have the means to buy seeds, and they prefer to exchange their work for seeds." In a women's focus group discussion, participants said that access to seeds, especially rice, is becoming a significant problem because of their high cost compared to the women's daily earning potential.

Farmers' Production strategies are more sensitive to seed access and less sensitive to markets

The above figures and tables on the seed that farmers planted last year is a snapshot of one moment in a volatile production system that is harried by cyclones and floods. Last season, the farmers planted 16% less seed than they normally plant. The main reasons they provided for planting less last year were: lack of money to acquire seed (38% of respondents who planted less) and poor climate (29% of respondents who said they planted less). The next most frequently cited response for planting less (8% of respondents) was that seed was not available. The farmers indicated in the focus group discussions that the 2021–2022 agricultural season produced poor harvests due to several cyclones (Batsirai and Emnati) and their associated floods. As a result, the farmers were more stressed at the beginning of the 2022–2023 agricultural campaign, and they had less access to seed.

For the three primary crops, the farmers' production strategy is highly sensitive to their access to seed and less sensitive to markets. The SSSA also surveyed farmers about how much they intend to plant in the upcoming agricultural campaign. The farmers indicated that they will plant 13% more seed in the upcoming season. The main reasons they provided for intending to plant more were: more seed available after a good harvest (22% of respondents), more seed available from seed distributions (18%), and prioritizing agriculture more in the upcoming season (26%). Only 8% indicated that they plan to plant more in response to market opportunities. The sensitivity of farmers' production to seed access is also demonstrated with individual crops. The respondents claimed that they intend to plant 42% more bambara nuts next year (roughly a quarter of respondents who received seed aid were given bambara nuts). The sensitivity of their three main crops to seed access and not markets is logical because these are subsistence farmers, and their three main crops are primarily for household consumption. In focus group discussions, the women indicated that they are sensitive to market demands when deciding what vegetable crop to grow, as they sell more of their vegetable production.

Because the farmers' production strategy is highly sensitive to their access to seed, seed aid can have outsized impacts. However, it appears that seed aid was poorly timed in the last few years. Roughly half (44%) of the farmers received free seed distributions in the last five years. The 2021–2022 agricultural season produced poor harvests due to several cyclones and their associated floods. However, only 13% of farmers received seed aid between the 2021–2022 and the 2022–2023 seasons. Meanwhile, farmers experienced a bumper crop during the 2022–2023 season. Yet, 85% of farmers received seed aid in the last year.

Two conclusions emerge from this data. One, it appears that farmers received seed aid a year too late. Two, farmers planted 16% less seed last year because they were recovering from a bad harvest and did not receive much seed aid. However, they intend to plant 13% more seed next year because they are coming off of a bumper harvest, have fuller stocks of seed/grain, and received seed aid in the last year. Seed access plays a crucial role in their production system.

Modern vs. Local Varieties of Rice

In Atsimo Atsinanana, the demand for local/traditional varieties of rice was high, and the demand for the available improved variety of rice (X265) was low. According to multiple actors in the seed system, the demand for improved rice varieties was low for two main reasons. One, local/traditional varieties are much more accessible and affordable. Local varieties are more accessible because farmers can exchange their labor and future harvest for seed. The informal seed producers of traditional varieties give out loans to farmers and allow them to repay their loan in grain after the harvest. They often use 'bongary' (a 2:1 exchange of grain for seed), but other informal seed producers exchanged seed for grain on a 1:1 ratio because encouraging exchange provides another avenue for the seed producer to discover new varieties that they can multiply, expanding their businesses. Local/traditional varieties from informal seed producers are also more affordable than certified seed. For example, farmers could buy certified seed of the improved variety (X265) for USD 0.66 per kilogram and a local/traditional variety for USD 0.33 per kilogram. Purchasing seed from informal seed producers does not prevent farmers from obtaining improved varieties. The informal seed producers also sell improved varieties, but they

were one generation removed from the source. Thus, farmers could buy certified X265 rice (R1) for USD 0.66 per kilogram, or they could buy X265 rice (R2) from an informal seed producer for USD 0.33 per kilogram. In many locations, the farmers could even trade their rice grain for X265 seed (R2). Thus, the informally produced seed was more accessible and affordable, and it did not limit the farmers' varietal options.

The second reason for the low demand for certified seed is that the improved rice variety requires chemical fertilizers and more weeding to achieve higher yields. The farmers in Atsimo Atsinanana generally did not use chemical fertilizer; 96% of the respondents to the individual survey stated that they did not use chemical fertilizer last year. The main reason for not using chemical fertilizer was cost (see Table 19). This response is logical, given the volatility of their agro-ecological system. Climatic variability disincentivizes farmers from investing in inputs. Investing in certified seed and chemical fertilizer can produce high yields if everything goes right, but farmers who invest in expensive inputs lose money when tropical cyclones like Freddy in 2023, Batsirai and Emnati in 2022 hit Atsimo Atsinanana year after year. Extensive agriculture is a logical response to climatic uncertainty — it hedges against financial losses in bad years.

Table 19: The main reason farmers gave when asked why they do not apply chemical fertilizer

Reason	**Percentage of farmers**
It's too expensive	64%
It's not available	18%
It's not necessary	9%
I don't know how to use it	6%
I use other soil fertility methods	3%

Farmers also maintain their soil fertility with organic inputs; 63% of farmers reported that they apply manure or compost to their fields. Most of that organic material (80%) is applied to their three main crops — rice (32%), cassava (23%), and sweet potato (25%). Most of that compost comes from cattle.

Table 20: Source of organic soil amendments

Source	Percentage of farmers
Larger livestock, mainly cattle	62%
Poultry	11%
Crop residues	17%
Kitchen waste	10%

The low percentage of farmers who apply chemical and organic fertilizers is indicative of labor-constrained traditional agricultural systems. The fertility in a farmer's field needs to be continuously replenished. Farmers remove nutrients from the soil in the form of rice, cassava, and sweet potato harvests — annual crop production mines the soil of its fertility. If only 4% of farmers in Atsimo Atsinanana use chemical fertilizer and 80% of farmers apply organic soil amendments, how do the remaining farmers maintain their soil fertility? Rice is predominantly grown in the flood zones at the base of watersheds. Periodic flooding deposits new soil material in these basins and can restore some of the soil fertility to rice fields. For the hillside production

of cassava, sweet potato, and other crops, the farmers use a combination of fallowing fields and slash-and-burn (swidden) agriculture. Relying on the natural regeneration of soil (via floods, burning, and fallowing) is a non-labor-intensive means of managing soil fertility. Numerous actors stated that agriculture in Atsimo Atsinanana is a land-constrained system. Lack of access to land prevents poor farmers from expanding production. However, labor is also a major constraint in unmechanized agricultural systems, especially in regions like Atsimo Atsinanana, where a large portion of working-age men move to nearby cities to earn a daily wage. Hauling manure, terracing rice fields, and slogging through a flooded rice field with a recalcitrant bull is grueling work. When farmers resist the intensification of agriculture or rely on natural forces to replenish their soil fertility, it is not because they are lazy. It is a logical response to a physically demanding profession. Extensive/traditional agricultural practices are a logical response to the grueling nature of unmechanized agriculture. As stated above, extensive/traditional agriculture is also a logical response to climatic uncertainty as it hedges against financial losses in bad years. Intensive investments in agriculture produce high yields only when the climate cooperates.

In focus group discussions, men and women farmers said that they favor traditional agricultural practices, even though they already know modern techniques produce larger harvests, primarily because they do not have the time/labor to adopt modern techniques. The farmers said that their traditional varieties degrade over time, and they want the government to release certified traditional varieties so they can access traditional varieties of high (genetic) quality. However, agents of the SOC said that government agencies have not done this. The farmers' traditional practices use extensive agricultural techniques that rely on natural soil regeneration processes and less labor/financial inputs. These traditional/natural soil regeneration practices explain how more than a third of the farmers responded that they do not apply chemical or organic fertilizers. The labor constraint also helps explain the farmers' preference for local varieties that produce sufficient yields without intensive weeding regimes and labor-increasing applications of fertilizers. Thus, when the farmers indicate that their local varieties are well adapted to their context, they are saying that these varieties are not only adapted to the bio-physical context (local soils, erratic rainfall regimes, recurring cyclones, and pest issues) but also adapted the social context (local labor-constrained households). The farmers' preference for local rice varieties is confirmed by the strong presence of traditional rice seed producers who successfully sell many local varieties to the farmers, while certified seed producers in Atsimo Atsinanana only manage to sell seed to projects (see Table 21).

Informal Seed Producers vs. Certified Seed Producers

The certified seed producers of rice, cassava, sweet potato, beans, and bambara nuts all claimed that their main challenge is marketing their products because their main customer is projects (that inevitably end). Consequently, the long-term visions of the certified seed producers were to seek out more projects to buy their seed and receive more aid from the projects. Meanwhile, the long-term visions of the informal/traditional seed producers were to increase their production to meet local demand, improve the quality of their seed, find more varieties to produce, and gain access to financial services to facilitate expansion. The informal/traditional seed producers stated their goal is to generate revenue while supporting local farmers. Many of these informal seed producers stated that they do not even have to go to the market to sell their seed because the farmers come to them. Some of them stated that they take periodic trips to other zones in search

of the next great variety in their zone, and when they start producing new varieties, they rely on word of mouth to generate interest. When the informal seed producers begin selling a new variety, the farmers come to them.

Table 21: Certified seed and informally produced seed produced in Vangaindrano and Farafangana in 2022–2023

Crop	Certified Seed				Informal Seed			
	Producers	**KGs**	**Variety**	**Buyer**	**Producers**	**KGs**	**Variety**	**Buyer**
Rice	1	3,500	X265	Project	8	15,005	Endriben'ny Mandigny, Endrin'ny Mandigny, Endrin'ny Paulin, Madinika, Malita, Maroanaka, Sibota, Tsimahorimena, Tsimikitra, Tsy mahory, Vary Hosy, Vary Somotry, X265, Zavamena	Farmers
Cassava	1	200	Madarasy	Project	3	3,150	Ambanisepa, Betany, Kazahamena, Madarasy, Mavomomoky, Menemolotra, Tomboraivitsy	Farmers
Sweet Potato	2	7,000	Maharavo, Bora, Irene	99% to Project, Few Farmers	3	1,640	Bora, Donga, Marshale, Vietnam	Farmers
Yams	2	500	Fotsy	Project	1	1,000	Florida	Farmers
Beans	2	3,800	Rouge, Ran'omby	Project	0			
Bambara Nuts	1	3,600	Voanjo Fotsy	Project	0			
Total	**9**	**18,600**	**9**	**Projects**	**15**	**20,795**	**27**	**Farmers**

While the quality of the certified producers' seed is controlled by agents of the SOC, the informal seed producers control the quality of their own seed. The lack of independent oversight bodies to control the quality of informal seed can lead to poor quality seed. The informal seed producers use traditional production practices, and only sometimes do they apply chemical fertilizers to ensure the seed crop is sufficiently nourished. Thus, the health/quality of certified seed is better controlled and maintained.

The certified seed producers also talk about seed production differently than the informal seed producers. Certified seed producers started producing seed because they were incentivized by a project. They all stated that a project initiated their enterprise by providing the start-up capital, equipment, training, and the market (the project buys the certified seed and distributes it for free). They spoke about certified seed production as an excellent business opportunity that they gratefully received. The informal seed producers, however, spoke about seed production as a vocation that is embedded in their cultural and family histories. Several of the informal seed producers are the children of seed producers. They continue to sell varieties that their fathers identified in faraway zones years ago and spoke of the pride they feel in contributing to their community's food security. One local producer of cassava planting materials said:

> One of the informal seed producers described his process of producing informal seed: "*Before sowing, it is essential to carefully sort out bad seeds. Next, the plot must be carefully plowed, and water conditions must be adequate to meet grain germination needs. Once the plot is well maintained, rice is sown. When the rice is ready for transplanting, it is transplanted into the rice field. It is important to regularly monitor the temperature and remove weeds growing between the rice leaves. Subsequently, the rice grains grow, gradually mature, and become ready for harvest. Harvesting involves collecting the grains by removing the stalks. Then the grains are dried. Once completely dry, we sort the seed by hand to eliminate bad seeds and unwanted weeds… We do not have any specific infrastructure or equipment related to seeds, with the exception of a large nylon mat used to dry the grains. Then, we sort and clean the seed manually, and store the seed in a large bag [in the attic]. Seeds of different varieties are stored separately.*"

> "*I inherited the traditional techniques of cassava production from my grandparent. I started this activity since I was independent of my parents. The production of cassava is an ancestral culture. All the farmers do this activity to ensure food security. Cassava is part of the basic diet of all farmers in the area. Selling cassava stalks is not a source of income for me, but an additional action to help farmers survive famine* […] *Many farmers do not have cassava stalks at planting time because they harvested their crops too early in the previous season to prevent them from being stolen. Their immature stalks are not yet of good quality to be replanted for next season, and that is why farmers don't have cassava seeds.*"

The altruism and nobility of seed production may be exaggerated in this account. Informal seed production is a profitable enterprise. However, this type of pro-social framing of a profession often occurs when people derive meaning from their work. The responses of the informal seed producers indicate that their seed production is motivated by a sense of community and family/cultural histories. The informal seed producers indicated that they could benefit from project support but will continue to produce seed with or without the short-term aid of the next development project. However, the certified seed producers indicated that their production slows down to almost nothing when projects do not buy their seed.

Certified seed producers and informal seed producers also spoke of different challenges. The certified seed producers said that their major challenges are acquiring the financial resources to purchase equipment and inputs (e.g., base seed, fertilizer, pesticides) needed to meet the required

standards of certified seed production and finding projects that can support these financial needs and buy the certified seed they produce. Informal seed producers mentioned these challenges:

- Lack of financial means to expand seed production
- Lack of arable land to expand seed production
- Lack of agricultural equipment and inputs (e.g., traction, plow, harrow, etc.)
- Lack of new varieties that are drought resilient and adapted to the agro-ecological characteristics of the region
- Insufficient labor

The challenges of the informal seed producers focused on expansion, while the challenges of the certified seed producers focused on making ends meet and the survival of their businesses. As a result of the low demand and high price of certified seed, local certified seed producers were difficult to find, and they sold their seed exclusively to development projects. Producers of local/traditional varieties were easier to find, and their product was in high demand.

Box 2: An Informal Seed Producer

Of every five kilograms of rice that farmers plant, one kilogram of seed is acquired from another rice farmer in the community. Nearly all the rice seed that exchanges hands within social networks is bought and sold. The vendors of this rice seed are informal seed producers. These informal seed producers meet local demand for rice seed. Toky (a pseudonym) is one of these informal seed producers in Atsimo Atsinanana. His household produces roughly 12,000 kilograms of rice on 15 hectares during the main rainy season. Toky sells roughly 3,500 kilograms of seed every year. He sells the improved/modern varieties for the same price as the traditional varieties (USD 0.28USD/kg after harvest and USD 0.37/kg before the planting season. He is very aware of how much seed he sells because he dries his rice seed for fewer hours than his rice grain. Toky's seed production includes improved varieties (X-265 and Sibota) and traditional varieties: Eng Pollen, Eng Madine, Enchiben ny Mandiguy, and Varim Bazaha.

Table 22: Varieties produced by an informal seed producer

Rice Seed Sales by Variety	
Endrin'ny Paulin	50%
X265	20%
Sibota	15%
Endrin'ny Mandigny	15%
Endriben'ny Mandigny	10%
Varim-bazaha	New
Lema	New

Toky is looking for the next new variety that is well-adapted to the agro-ecological context, local gastronomic preferences, and available grain processing practices. He looks for new varieties in several ways. He identifies especially good rice fields when travelling to visit family and friends and asks the farmer if he can purchase some seed after the harvest. He travels to other regions where he has social connections with the specific goal of finding new varieties. He visits agro-dealers in nearby cities to buy improved varieties. When farmers buy seed from him, he allows them to exchange an equal weight seed for grain. If they give him a new variety, he asks the farmer about its production, processing, and gastronomic qualities. This is how he found his latest variety, Varim Bazaha. Moving forward he would like to focus his seed production on Varim Bazaha because his top seller, Eng-Pollen, is in its eighth generation and quality has degraded.

Once Toky identifies a promising variety, he plants 12 kilograms. If it produces a good harvest, he tests its processing qualities, taste, and fluffiness when cooked. If he believes the variety would meet local demand, he gives 12 kilograms of seed to extended family (they live in many villages throughout Atsimo Atsinanana) and eneourages them to plant the new variety. If other farmers express interest in this new variety, they are referred to Toky.

His annual income from seed production is difficult to calculate because he exchanges more seed than he sells. He says that he produces seed because he is proud to produce new varieties that increase his neighbors' production, just as his (deceased) father did before him. His family is also involved in local politics; his benevolent seed production could have a political component as well.

Formal Breeding of Important Varieties in Atsimo Atsinanana

While informal seed producers are producing both improved varieties (R2) and the traditional varieties that were sown by their parents and grandparents, certified seed producers focus on

improved varieties that were generated at national research institutes. Madagascar's government institutions play a central role in the development, multiplication, and delivery of new varieties for the crops that are most important to Malagasy farmers. The main agencies involved in breeding and selection are Fiompiana sy Fambolena Malagasy sy Norvegiana (FIFAMANOR) and the National Agricultural Research System, also known as FoFIFA.

FoFIFA and FIFAMANOR benefit from government and bilateral donor funding, but their operating budgets have shrunk in the last decade. The distance of their sparse research stations from many regions of Madagascar is directly linked to their budget constraints. FIFAMANOR's closest research station in Antsirabe is 510 kilometers north of Farafangana and 600 kilometers north of Vangaindrano. Antsirabe is on the plateau in a subtropical highland climate. FIFAMANOR breeds food crops in an agro-ecological zone that is quite different from Atsimo Atsinanana. As discussed above, the farmers seek out varieties that are well-adapted to the unique agro-ecological conditions of their region. The varieties that FIFAMANOR selects in Antsirabe will not necessarily meet the demands of farmers in Atsimo Atsinanana. FoFIFA's closest research station in Kianjavato is closer to Atsimo Atsinanana, only 221 kilometers north of Farafangana and 310 kilometers north of Vangaindrano. Kianjavato is not on the plateau, and it more closely resembles Atsimo Atsinanana's agro-ecological context.

FoFIFA is comprised of six main research departments, two of which focus on breeding: The Département de Recherches Agronomiques (DRA) concentrates on food crops such as maize, cassava, and legumes and the Département de Recherches Rizicoles (DRR) specializes in rice research. As a whole, FoFIFA:

- Conducts genetic research on food crops to improve their performance and resilience and breeds new varieties that:
    - exhibit generally desirable characteristics, such as high yields and nutritious content, pest resistance
    - are adapted to the diverse agro-ecological contexts throughout Madagascar
    - meet the farmers' local gastronomic and processing preferences
- Conducts varietal testing to determine the suitability and yield potentials of these new varieties under the numerous agro-ecological contexts within Madagascar. Matches promising new varieties to particular agro-ecological zones
- Ensures the availability of high-performing seeds via seed multiplication and dissemination activities
- Researches and diffuses sustainable agricultural practices (soil fertility management, irrigation methods, and pest and disease control, etc.)

FIFAMANOR focuses on root and tuber crops, especially sweet potato. They breed improved sweet potato varieties that are more nutritious, more resistant to pests and diseases, and have higher yield potential. They also breed other tuber crops (mostly cassava and yams). FIFAMANOR conducts varietal testing to determine the suitability of these new varieties to different agro-ecological contexts. They work on multiplication to ensure availability throughout Madagascar, and they promote the adoption of these new sweet potato varieties among local farmers. In addition to their breeding and dissemination activities, FIFAMANOR also engages in broader rural development initiatives, including income generation, food security, and community development.

According to our discussions with certified seed multipliers in Atsimo Atsinanana, there is a dearth of new varieties entering the region (see Table 21 above). NGOs that support seed producers in the region reported that they have difficulty obtaining foundation seed from FoFIFA and FIFAMANOR. The seed that NGOs are able to distribute is not especially new. The improved variety of rice that NGOs and government programs distribute is X265. This is a short-cycle variety with high yield potential and high fertilizer requirements. It was released in 1986.[xiii] One of the varieties of cassava (Madarasy) that is currently purchased and distributed by NGOs in the region was around in 1950.[xiv] NGOs are purchasing and distributing three varieties of sweet potato. One, Bora is an orange-fleshed sweet potato variety developed by FIFAMANOR in the 2000s.[xv] Two, Irene is another orange-fleshed sweet potato; it was first introduced in Madagascar in 2017.[xvi] Three, Maharavo is a traditional variety of sweet potato.[xvii] X265, Madarasy, Bora, Irene, and Maharavo are the new varieties of the three main food crops that are produced and distributed in Vangaindrano and Farafangana. Beyond FoFIFA and FIFAMANOR, the SSSA research team did not find any evidence of other institutions releasing new varieties of food crops in Vangaindrano and Farafangana.

The improved varieties that have arrived in Atsimo Atsinanana were multiplied by the handful of certified seed producers. The government agents at the SOC (who ensure the quality of certified seed) were eager to support certified seed producers. However, NGOs are the only entities that pay the SOC to undergo the seed certification process. The costs of SOC certification include on-farm inspections of seed production and analysis of a seed sample at the SOC's national laboratory in the capital of Madagascar, Atananarivo. When asked how much independent seed producers must pay for the process to certify their seed, the agents of the SOC stated that no farmer in their districts ever paid for the service. They were dismayed by the lack of demand for certified seed. They said that demand is low because the farmers are reluctant to pay the extra money for certified seed, and when farmers do plant certified seed, they are disappointed by the harvests. The agents of the SOC said that the farmers believe that improved varieties should automatically increase yields. The main improved rice variety in the region (X265) only produces increased yields if the farmers adopt modern agricultural practices, including chemical fertilizer application and timely weeding. According to the agents of the SOC, the farmers were reluctant to adopt modern practices and, therefore, reluctant to adopt improved varieties.

Table 23: Recent Seed distributions in Vangaindrano and Farafangana

Organization	Crop	Variety	Amount distributed
ADRA	Rice	X265	150 tons
ADRA	Maize	IRAT 200	120 tons
ADRA	Bambara nuts	Voanjobory fotsy	120 tons
WHH	Rice, maize, beans, Bambara nuts	"Improved variety"	27 tons
WHH	Sweet potato	"Improved variety"	17 tons
Government	Rice	"Improved variety"	31.25 tons
Government	Common Beans	"Improved variety"	10 tons
Government	Maize	"Improved variety"	5 tons
AFAFI Sud	Cassava	Kazahavily	3 large truckloads

A few development initiatives in Atsimo Atsinanana have trained farmer associations to produce cassava and sweet potato planting materials that qualify as QDS. In these cases, the NGOs monitor the quality and purchase all of the products, which they distribute to vulnerable farmers who need planting materials. Again, there were not any farmers who paid to have their planting materials certified as QDS.

Delivery of Seed and New Varieties

In the individual survey, farmers were asked if their households received/obtained a new seed variety in the last five years. To be clear, farmers obtained a variety that is *new to them*, even if it is a local variety from a neighbor; this counts as a 'new variety' for the purposes of this survey question (see the third column of Table 24.) NGOs are the main source of new varieties for the 559 respondents of the household survey. In the last five years, 47% of the farmers planted a new variety, and 44% received seed aid. (To put this in perspective, in a recent SSSA conducted in southern Madagascar, only 8% of the farmers planted a new variety in the last five years.[xviii]) In Atsimo Atsinanana, the majority of the new varieties (67%) that farmers planted were generated by FoFIFA and FIFAMANOR, multiplied by certified seed producers, and distributed by NGOs. However, the local market and the respondents' social networks were also an important source of new varieties. The farmers in Atsimo Atsinanana are eager to adopt new varieties. They are seeking out and purchasing new varieties independent of the free seed that NGOs distribute.

Table 24: Source of seed and new varieties

Source	Percentage of seed farmers planted from various sources in 2022	Percentage of new varieties farmers planted from various sources in 2022
Local Market	42%	18%
Saved Stock	37%	N/A
Friends, Family, Neighbors	21%	15%
NGOs	0.4%	67%
Agro-dealers	0%	0%

The Local Market

The local market is an important source of new varieties for farmers in Atsimo Atsinanana and is also their *main* source of seed. The more vulnerable farmers go to the market to buy seed because of food insecurity. As discussed above, they run out of grain before the planting season and eat the grain they had set aside as seed. Less vulnerable farmers go to the market to purchase good quality local seed. Regardless of their diverse reasons, farmers in Atsimo Atsinanana go to the local market to buy seed, and when they get there, they often purchase new varieties. The farmers are open to varietal innovations.

The grain vendors at the local market reported farmers often say when they want to buy seed instead of grain. According to the vendors, the farmers tend to seek out clean seed that is separated by variety, and they often indicate the variety they want to buy. These vendors at the local market have responded to this demand for seed. The vendors cater their products to the farmers' needs. The vendors seek out specific varieties, buy grain from regions that produce seed

that is well adapted to the region, sort out waste and bad grain from the seed, and even conduct germination tests (see Table 24).

Table 25: Grain vendors' special treatment of (potential) seed

Activity	**Atsimo Atsinanana**	**Average from 10 other SSSAs in Africa**
Number of traders	24	211
Get grain in specific regions believed to have grain that is well adapted to the local area	74%	80%
Seek out specific varieties to buy (which can be planted)	55%	75%
Buy from specific growers who are known for high-quality seed	26%	48%
Keep varieties pure	60%	73%
Keep freshly harvested stocks apart	26%	71%
Grade stock (which grain/ which seed)	36%	39%
Do germination tests	52%	10%
Have special storage conditions (for seed viability)	19%	45%
Sort out waste (pebbles, dirt, etc.)	62%	71%
Sort out bad grain that is broken, discolored, or immature	62%	65%
Sell seed and grain separately at different prices	24%	43%

The grain vendors in Atsimo Atsinanana significantly diverge (>20% difference) from the average vendor when it comes to germination tests and storage. A high percentage of the Atsimo vendors conduct germination tests, indicating that their farmer-clients are particularly interested in germination rates. In terms of storage, it appears local vendors are less attentive to storage conditions than vendors in other countries on the African continent.

Agro-Dealers

The survey team dispersed into four communes in two districts and found only four agro-dealers. The absence of agro-dealers aligns with other studies. An analysis of formal agro-dealers in Madagascar found that there is an average of one agro-dealer per 17,300 rural households.[xix] For the most part, the agro-dealers found in Atsimo Atsinanana were operating out of a small shack where they sold vegetable seed for market gardening, some pesticides, and a small quantity of fertilizer. These four agro-dealers bought their vegetable seed packets from other private companies in the region; they did not buy certified seed from local seed producers. They said that vegetable seed, pesticides, and fertilizers were the only products they could sell in rural Atsimo Atsinanana. They also said that they have difficulty selling their seed when NGOs distribute seed for free. They mostly conducted their businesses in cash and occasionally sold their products on credit. The agro-dealers' claims aligned with the individual survey data. According to the individual surveys, farmers did not obtain any of their seed for their principal crops from agro-dealers.

Box 3: A local grain trader

Tsilavina (a pseudonym) is a relatively wealthy farmer in his community who engages in the local rice market. He sends his employees into the neighboring villages after the harvest to buy grain. Supply is high after the harvest and demand is low. Nevertheless, many farmers are willing to sell rice at this inopportune time because agricultural production is an important source of income and they have to pay off their debts. Tsilavina stores the rice until the lean season, when the demand rises and the supply falls. He can sell the rice for as much as USD 0.70 per kilogram during the lean season, and he sells rice to retailers from the nearby city at USD 0.68 per kilogram (covering transportation costs). Tsilavina needs at least USD 0.10 per kilogram in profit to cover his transportation and labor costs, not including storage losses. In general, Tsilavina needs roughly USD 0.20 in profit per kilogram to make the enterprise worth his while. Thus, he prefers to buy rice when the price falls to USD 0.50 per kilogram. Some years the rice falls that low, and he buys 5,000 kilograms of rice after the harvest in surrounding villages. Other years, the price of rice falls to USD 0.55, and he buys 2,000 kilograms. And still other years, the price remains too high after harvest to buy. Tsilaven is an small scale grain trader in his community.

Tsilavina also decorticates rice. He owns one of the two decortication machines in his village. He charges farmers USD 0.03 per kilogram to decorticate rice and keeps the bran, which he gives to his pigs, ducks, and chickens.

Conclusions

Farmers in Atsimo Atsinanana are open to adopting new varieties, and yet they obtained 99% of their seed via the informal system. They buy the varieties that meet their preferences from vendors at the market and from informal seed producers. When they do not have enough money to buy seed, they take out seed loans that are most often repaid with twice the quantity of grain after the harvest. The farmers only seem to access the formal seed system when they receive free certified seed from NGOs or when they buy small packets of vegetable seed for their gardens.

Buying seed is a risky proposition for a subsistence farmer because seed is a black box (farmers cannot divine seed's genetic qualities from its appearance), and farmers put their family's food security on the line every time they buy seed. When a farmer in Atsimo Atsinanana buys poor quality seed that does not produce a good harvest, their family must live with the dire consequences. Farmers throughout the Global South resolve the risks of buying seed in one of two ways. One, they buy certified seed or QDS that has been rigorously evaluated to ensure its seed health/quality. Two, they buy seed from a trusted source within their social network. The farmers in Atsimo Atsinanana acquire 99% of their seed using the second method. The farmers buy seed from trusted local seed producers whose entire business model relies on repeat business within their communities. These informal seed producers take pride in producing good quality seed for their neighbors. The farmers also buy seed from vendors at the local market, and half of the vendors conduct germination tests so they can report the germination rates to their farmer-clients. Trust-based systems can be exploited by bad actors who make one-time deals. However, the informal seed system in the communities of Atsimo Atsinanana is based on long-term relationships and repeat business. The trust-based informal system has fewer costs, and the seed

is less expensive as a result, which suits the resource-poor farmers in Atsimo Atsinanana. However, the seed quality is not as rigorously maintained as seed in the formal system, which uses laboratory control measures to investigate seed health/quality. Nevertheless, numerous farmers reported that the certified rice seed that they received from NGOs has a poor germination rate. Agents from the SOC and an NGO distributing seed in Atsimo Atsinanana confirmed that farmers complained of the germination rate in the certified rice seed. Actors in the seed system believed that the farmers must have held on to the seed for too long, diminishing its quality. From many farmers' perspectives, the certified seed does not meet their preferred (traditional) agricultural practices, and the seed quality is not necessarily reliable.

Despite farmers' current preference for their traditional seed, the seed system can deliver the innovations farmers need to be resilient to shocks and stresses only when both the formal and informal seed systems are functioning. Relying almost entirely on the informal system threatens the farmers' resilience to the shocks and stresses associated with a changing climate. The survey respondents repeatedly stated that they preferred traditional varieties of rice are degrading. The informal seed producers are tuned in to the farmers' preferences because they live in the same communities and farm the same crops. However, these informal seed producers lack the technology, expertise, and infrastructure to maintain foundation seed for the preferred local varieties. The informal seed producers traffic in germplasm that degrades and changes every year. They cannot maintain the genetic quality of their seed, so they must constantly seek the next local variety that farmers will buy. They also search for new varieties that are better adapted to their rapidly changing environment. Thus, informal seed producers are charged with the difficult task of identifying and selling an ever-shifting germplasm to meet farmers' needs in a rapidly shifting environment. They attempt to accomplish this difficult task by "keeping an eye out" for other good varieties in their communes or traveling to other districts to find local varieties that could grow well in their own communes. This process is haphazard and unsystematic. Breeders at FoFIFA and FIFAMANOR follow proven methodologies to identify promising germplasm from around the globe, rigorously test them in local growing conditions, and select the varieties that enable farmers to adapt to a changing climate and fluctuating market forces. The formal seed system can leverage global genetic resources and scientific processes to deliver innovation to farmers in Atsimo Atsinanana. The formal seed system is underperforming in Atsimo Atsinanana, and the farmers' seed system lacks innovation as a result.

VI. RECOMMENDATIONS

This evaluation did not find an immediate seed security crisis that would necessitate an emergency response or an immediate seed distribution.

This SSSA did identify chronic and acute stresses to the seed system. The chronic stress is the farmers' overreliance on the informal system and the resulting lack of innovative germplasm. The acute stresses are the cyclones, flooding, and droughts that hinder food security and the adoption of modern agricultural practices and improved varieties. The chronic and acute stresses are interwoven. The acute stresses depress agricultural incomes and hinder intensive agricultural practices. Subsistence farmers are poorer as a result, making them less able to invest in improved seed and leading to a moribund formal seed system that fails to deliver innovative germplasm. Farmers in Atsimo Atsinanana rely too heavily on the informal system, and the formal seed system is underutilized. Consequently, the seed system as a whole lacks innovation. To catalyze the formal seed system, development interventions need to address the low demand for improved varieties and the low supply of certified seed and QDS. Demand for improved varieties of rice, sweet potato, and cassava can be created by easily replicated varietal demonstrations, farmer field days and other publicity efforts that attract farmers to the demonstration fields. This will require collaboration with diverse stakeholders from both the public and private sectors, emphasizing a long-term perspective and commitment.

When acute stresses do occur, development interventions should distribute seed to vulnerable households because the farmers' production strategies are highly sensitive to their access to seed. This SSSA showed that farmers planted 16% less seed than normal in the year following a poor harvest and 13% more seed in the year following a bumper harvest. Seed distributions after cyclones and droughts should start with the principal crops (rice and cassava) and then venture into secondary subsistence crops (beans and bambara nuts). Rice seed should be distributed because rice fields are destroyed by cyclones. Cassava plantings are also harder to find after cyclones because the high winds damage the crops. After a cyclone, industrious farmers and middlemen travel up to the plateau (where the cyclone did not reach) to buy cassava planting material and transport them to Atsimo Atsinanana. However, according to government agents in Atsimo Atsinanana, this market-based strategy takes a few years to replenish the local supply of cassava planting materials. Cassava is crucial to food security in Atsimo Atsinanana and should be included in distributions.

In the absence of acute seed stress, development interventions should refrain from distributing seed. Several actors in the seed system, including agro-dealers and agents of the SOC, claimed that seed distributions should only occur after cyclones and droughts strike the region when farmers do not have access to seed. They claimed that the seed distributions occurring after normal or good harvests undermine demand for certified seed.

Increase Demand for QDS and Certified Rice Seed

Demonstrations and dissemination strategies that account for labor constraints

In focus group discussions, the farmers said that rice production is their most labor-intensive crop, and it is their main staple crop for household consumption. The main barrier to the adoption of certified rice seed is not the cost of the seed itself. The main barrier is the cost of the modern/intensive agricultural practices that are necessary for the certified seed to produce higher yields. Farmers in the focus groups indicated that they know that improved seed and modern agricultural practices produce higher yields, but labor constraints prevent their adoption. They favor traditional systems and local seed varieties that require less labor. The true extent of labor constraint in unmechanized agriculture is difficult for development practitioners to appreciate from their less physically demanding professions. In the absence of mechanization, agricultural labor wears bodies down. The amount of leisure time that farmers have is immaterial. In as much as the farmers think the labor constraint prevents the adoption of modern practices, they are necessarily correct because they are the ones who ultimately decide whether to work even harder. Furthermore, promoting agricultural intensification introduces social risks because women are often the subordinate group in a household, and increasing agricultural labor can be a gendered and conflictual process. Government agents and development actors should thus accept the labor constraint as a real barrier and resist the temptation of saying, "If the farmers just worked a little harder, they could…"

Once we accept the labor constraint, we can more carefully consider the farmers' resistance to modern practices. For example, farmers could adopt modern practices without increasing labor if they farmed less land more intensively. However, they choose not to do this because they believe farming more land using extensive/traditional practices will produce higher or more stable yields than farming less land using intensive/modern practices. Therefore, public demonstration plots would need to hold labor constant by comparing the yields of larger fields farmed traditionally to smaller fields farmed with new varieties and modern practices. But what about the households farming less than a half hectare who presumably have unused agricultural labor at their disposal? They may be the best target for activities designed to increase the adoption of improved varieties and modern agricultural practices. Implementing NGOs could provide training, improved seed, and chemical fertilizer to farmers who farm less than a half hectare because these are the households that are more motivated to intensify production and most likely to have excess household labor. To fully understand the constraints to intensive production by these groups, further research should be conducted to ensure all factors affecting uptake of intensive production are well understood and considered.

Interventions that promote agricultural intensification among farmers with less land should focus on intensifying with organic soil amendments. Resource constraints are the main barrier to adopting chemical fertilizers, and the data show this financial barrier is greater among smaller landholders (see Table 26). However, the main barrier to applying more organic soil amendments among farmers with less than a half hectare is the lack of technical knowledge, and farmer training is exactly what development interventions are well-positioned to address.

Table 26: Percentage of farmers who do not intensify inputs and the main reason why

Characteristics	Farmers of <0.5 hectares	Farmers of >2 hectares
Do not apply chemical fertilizer	**97%**	**92%**
because it is too expensive	68%	48%
because it is not available	12%	31%
because it is not necessary / soil is fertile	7%	5%
Do not apply organic soil amendments	**57%**	**22%**
because they do not know how	72%	39%
because it is not available	7%	44%
because it is not necessary / soil is fertile	17%	17%

Combine demonstrations of improved varieties with alternative agricultural practices

Increase demand for improved varieties with farmer field schools demonstrations of improved varieties and other alternative agricultural practices (e.g., agro-ecology, conservation agriculture, system of rice intensification) to provide viable alternatives to traditional/extensive practices. The low yields of traditional/extensive practices can hinder a household's pathway out of poverty when land is so limited, as is generally the case with female-headed households. Alternative agricultural practices can increase yields without increasing inputs, expenses, and risks, but they require on-farm demonstrations and training to convince farmers. Coupled with alternative agricultural practices, farmers' demand for improved varieties could increase.

Seed loans for high-performing, improved varieties

In Atsimo Atsinanana, the household granaries are often emptied before planting season. The farmers exhaust their supply of saved stock and have nothing left to plant. They use their little bit of income to buy enough food to survive until the next harvest. As a result, they take out seed loans from informal seed producers and repay the loan with twice the quantity of grain after the harvest (bongary). Seed loans are an important means of accessing seed for farmers in Atsimo Atsinanana. However, seed loans are only available for local/traditional varieties in the informal seed system. As discussed above, the poorest farmers often have the least amount of land, and they could be more open to intensive/modern agricultural practices and improved varieties. They are also the least likely to have the cash on hand to buy improved/modern varieties. Therefore, establishing a mechanism that enables poor farmers to take out seed loans for high-performing, improved varieties could increase demand.

Identify trusted seed vendors and agro-dealers to sell small packets of QDS and certified seed

The farmers already go to trusted grain vendors to buy seed. Many of these vendors stock up on varieties that farmers want to plant, sort out broken seed and waste, and conduct germination tests. These vendors could also start selling small packets of certified seed. The vendors could start to promote their sales, and this could increase demand for certified seed and QDS. This same strategy can be used with agro-dealers. The farmers are already going to agro-dealers for small packets of certified vegetable seed. Development interventions should encourage agro-dealers to market small packets of certified rice, beans, and bambara nut seed as well.

Breed and multiply performing/improved varieties better aligned with farmer preferences

As open-pollinated varieties, the preferred characteristics of the farmers' traditional varieties degrade over time. Several farmers stated that they wanted the government to find a way to certify their preferred traditional varieties, and agents of the SOC confirmed that farmers often request this. The farmers essentially want access to foundation seed for local varieties that have already degraded. This may not be possible, but it does point to potential solutions. The farmers are saying that they want improved varieties that are better adapted to their local agro-ecological contexts and can be successfully grown using traditional agricultural practices. FoFIFA and FIFAMANOR face hard decisions because of budget shortages. Issuing advice to these important institutions from the outside — without any awareness of internal political/funding constraints — is a fraught exercise. FoFIFA, FIFAMANOR, and other breeding institutions should consider breeding improved varieties that more closely resemble the characteristics of the farmers' preferred traditional varieties.

Seed fairs, seed vouchers, and small packets

Seed fairs are innovative and market-oriented approaches that enable farmers to access and experiment with seed of various crops and varieties. These fairs can be implemented in the target communes, bringing improved seed to farmers. Seed fairs empower farmers with options, as farmers can choose from a cornucopia of new varieties. These new varieties should include labels with information about the maturity period, optimal planting times, input requirements, and beneficial crop associations. This enables farmers to make informed decisions.

Numerous farmers said that they do not buy certified seed because it is prohibitively expensive. Small packets of certified seed lower its cost, enabling farmers to buy certified seed with less risk. A smaller packet of seed means the farmer can experiment with a smaller quantity of the certified seed, planting it in a corner field and observing the results without gambling household food security on the outcome. Seed is a black box, and farmers adopt new varieties incrementally. Given the farmers' reluctance to buy certified seed and adopt improved varieties, seed fairs in rural Atsimo Atsinanana locations are more likely to succeed if the implementing partner issues seed vouchers to farmers.

The seed fair/voucher intervention can replace seed distributions in years when farmers are not facing seed insecurity. Numerous actors in Atsimo Atsinanana's seed sector stated that seed distributions inhibit farmers' willingness to pay for certified seed. Seed fairs are market-based approaches. Once farmers start to see the value of the small packets of improved varieties, the voucher component of the program can be removed. Ultimately, seed fairs strengthen and decentralize the seed system, providing farmers with greater access to innovative germplasm.

In years when farmers are facing seed insecurity, seed distributions are preferable to seed fair/voucher interventions. Farmers are especially vulnerable in times of crisis; they can hardly afford to assume more risk with unknown new varieties. After a shock, they become even more risk averse, and they seek assurance that the upcoming agricultural season will produce enough

food to reestablish their household's food security. Thus, seed distributions in periods of crisis should focus on varieties that the farmers know and trust.[xx]

Increase Supply of QDS and Certified Rice Seed: Incremental Shifts from Informal Production to QDS and Certified Seed

Informal seed producers currently monitor and control their own seed quality. They are highly motivated to produce high-quality seeds with good germination rates, as their business model relies entirely on the repeat business of local farmers. Despite their incentive to maintain high-quality seed, the leap into producing certified seed appears to them like a poor business strategy because the cost of producing certified seed is high; thus, the seed itself is too expensive for the farmers, and the farmers generally prefer their local/traditional varieties over the certified seed varieties.

Development programs should create an incremental process for advancing informal seed producers to QDS and certified seed producers.

Step One: train informal seed producers, including agro-agents, in rigorous seed production practices (e.g., good production practices, pest management, quality control in the field, and seed selection/sorting, drying, and storage). Train informal seed producers as if they were QDS producers. QDS training programs educate seed producers on best practices for seed production, handling, and storage, ensuring that producers are equipped with the knowledge and skills needed to maintain seed quality. Their motivation to maintain/improve the quality of their product could make them eager to adopt some (if not all) of these improved practices. The goal of this training program is twofold. The immediate goal is to strengthen their seed production practices and the quality of the informal seed that they produce. The long-term goal is to encourage them to internalize the practices of rigorous seed production. That way, if/when the demand for QDS and certified seed rises, this cadre of informal seed producers will be ready to wade into QDS and certified seed production. Also, where feasible, connect agro-agents at the commune and Fokontany level with agriculture shops and dealers at the regional and district level for supply of quality seeds which can be repacked into smaller sizes and sold to farmers at the commune.

Step Two: Support the development of QDS bodies in southeast Madagascar. QDS programs can improve seed quality and traceability in regions like Atsimo Atsinanana, where supply and demand of certified seed is low. QDS programs need to establish seed production standards, on-farm inspections, rigorous seed testing, seed traceability and documentation, and quality assurance mechanisms. QDS programs require collaboration between seed producers, government agencies, NGOs, rural civil society associations, and farmers. Engaging all relevant stakeholders ensures that quality control measures are effectively implemented and monitored.

Increase Demand for Disease-Resistant Cassava Varieties

Cassava Mosaic Disease (CMD) is a chronic problem in cassava production in Atsimo Atsinanana. Other diseases negatively impacting cassava production (to a lesser extent) include Anthracnose and Cassava brown streak. However, none of the farmers in the eight focus group

discussions mentioned disease issues with their cassava production. According to agronomists in the region, the farmers did not mention these disease issues because CMD does not appear to directly impact yields. Despite appearances, CMD can decrease cassava yields by 30-40%.[xxi] Development interventions should implement demonstrations that compare disease-free cassava to the CMD-infected cassava found in their fields. These demonstrations could enable the farmers to see first-hand the importance of managing disease in their cassava production. IITA has released CMD tolerant cassava varieties. Development actors in Atsimo Atsinanana should identify the varieties that are most likely to meet local farmers' preferences, and then implement easily replicable demonstrations that include three or four new varieties and a locally farmed variety. Investments to make the cassava seed systems more resilient — such as replicated trials of improved varieties and training on disease recognition and management — need to be made regularly.

Increase Supply of Clean Planting Materials

Clean planting materials are a crucial control measure for CMD because cassava plants that originate from infected cuttings exhibit more pronounced symptoms and much lower yields compared to those of the same variety infected during the early stages of crop growth by whiteflies. Furthermore, cassava plants infected late in their growth stages experience minimal to no damage. Producers of cassava cuttings can drastically reduce the rate of diseased cuttings by visually inspecting fields and removing diseased plants. Madagascar is a vast country. Farmers who are sufficiently isolated from others can turn their isolation from a source of vulnerability into an advantage by propagating disease-free planting materials that are not infected by neighboring fields. Interventions in the seed system can also reduce CMD by multiplying and distributing CMD-resistant varieties. Past NGO interventions have created associations that produce quality-declared cassava planting materials. Future interventions should build off this base by training existing associations to produce disease-free planting materials. In communes where these associations do not exist, future interventions can establish new associations on isolated farms that produce quality-declared planting materials.

Introduce High-Performing Varieties from Other SADC Member Countries

SADC has established a harmonized seed regulatory system to facilitate the cross-border flow of seed among its member countries. The regional harmonization of seed legislation streamlines the processes for new varieties to enter SADC countries. Actors in the seed system should work to introduce high-performing varieties of rice, cassava, and sweet potato from other SADC countries. Actors in the Malagasy seed system should conduct on-farm testing to determine the suitability and yield potentials of these new varieties in Atsimo Atsinanana, as well as farmer preference trials to ensure incoming improved varieties meet local farmers' demands.

REFERENCES

[i] USAID-ATLAS. (2019). Climate Risk Profile, Madagascar. Climate Risks in Food For Peace Geographies.

[ii] USAID-FFP, (2019). Country Specific Information: Madagascar. USAID, Office of Food for Peace.

[iii] ACAPS, (2023). Madagascar – Tropical Cyclone Freddy exposure and vulnerabilities. https://www.acaps.org/fileadmin/Data_Product/Main_media/20230222_acaps_thematic_report_on_tropical_cyclone_freddy_exposure_and_vulnerabilities_in_madagascar_0.pdf

[iv] Reliefweb, (2022). Cyclones Batsirai and Emnati in Madagascar: how the private sector is responding. https://reliefweb.int/report/madagascar/cyclones-batsirai-and-emnati-madagascar-how-private-sector-responding#:~:text=Both%20cyclones%20hit%20almost%20the,or%20flooded%20by%20Emnati%20alone.

[v] Randrianirintsoa, H., Ravelomanansto, J., (2018). Rapport d'Activites Volet Manioc Projet Germination II. Valorisation et Preservation de l'Environment et des Ressources Naturelles. FoFIFA. https://www.fofifa.mg/wp-content/uploads/2020/03/rapport-GERMINATION_Manioc.pdf

[vi] USAID-FFP, (2019). Country Specific Information: Madagascar. USAID, Office of Food for Peace.

[vii] Tojo-Mandaharisoa S., Steinke J., et al. (2022). Assessing Farmers' Diverse Preferences and Expectations for Tailoring Food and Nutrition Security Interventions in Southeastern Madagascar. Current Developments in Nutrition. 6(10).

[viii] USAID-FFP, (2019). Country Specific Information: Madagascar. USAID, Office of Food for Peace.

[ix] Carney, J., & Watts, M. (1991). Disciplining Women? Rice, Mechanization, and the Evolution of Mandinka Gender Relations in Senegambia. Signs: Journal of Women in Culture and Society, 16(4), 651–681.

[x] The SOC Website https://soc-semences.mg/

[xi] Beauval, V., Di Leonardo, A. (2016) Etude de la filière semencière à Madagascar et plus particulièrement dans la zone d'intervention du Projet ASARA.

[xii] Beck, E. (2016) Repopulating Development: An Agent-Based Approach to Studying Development Interventions. World Development Vol. 80, pp. 19–32.

[xiii] Andrianary, H., Yasuhiro Tsujimoto, Y., Rakotonindrina H., Zaw A., Rabenarivo M., Ramifehiarivo N., Razakamanarivo H. (2021). Phosphorus application affects lowland rice yields by changing phenological development and cold stress degrees in the central highlands of Madagascar. Field Crops Research, 271(15).

[xiv] Cours, G., (1950). Le Manioc à Madagascar (Doctoral Thesis). L'Université de Paris. And http://www.cfnpp.cornell.edu/images/wp100engl.pdf

[xv] CTA, (ND). Patate Douce. https://www.doc-developpement-durable.org/file/Culture/Culture-plantes-alimentaires/FICHES_PLANTES/maladies/patate_douce%20Madagascar.pdf

[xvi] Ranaivoson, T. (2022). Adoption de la Patate Douce à Chair Orange : Le cas des Communes d'Ambohimandry et d'Imerintsiatosika, district d'Arivonimamo. Université d'Antananarivo école supérieure des sciences agronomiques.

[xvii] Rakotondramanana, J., Rasolomanjaka, J., (2016). Rapport de mission de reconnaissance et de diagnostic du projet Sohavelo Asara programme Européen de sécurité alimentaire et nutritionnelle dans les régions sud et sud-est de Madagascar ASARA / AINA.

[xviii] Sperling, L. (2023). SSSA in Southern Madagascar

[xix] Seed Systems Group (SSG) 2019. Madagascar : Potentialités du système semencier, RAPPORT FINAL Consultant national : RABENASOLO Imboasalamaniaina (Mbosa)

[xx] CRS (2015). Seed Aid for Seed Security, Advice for Practitioners. Practice Brief #5.

[xxi] Thresh, J., Cooter, R. (2005). Strategies for controlling cassava mosaic virus disease in Africa. *Plant Pathology*, *54*(5)