Opportunities for strengthening the sorghum value chain in Madagascar for more sustainable livelihoods

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Sorghum in Madagascar – Introduction

Multiple years of extreme drought have left more than a million people in Madagascar at high risk for malnutrition and severe income insecurity, particularly in the island country’s southern regions. These extreme climate events also created significant challenges to the traditional agricultural production systems upon which nearly 80 percent of the population relies for their livelihoods. Maize, in particular, has been impacted drastically due to the lack of rainfall, changes in rainfall patterns, and the intensity/regularity of windstorms. This, compounded by fall armyworm attacks, increasing input prices, and a general degradation of agricultural lands, has created a pressing need for new cereal production solutions - both to replace the lost source of revenue and food security for Madagascar’s maize producers, but also to supply a growing animal feed sector.

While sorghum has traditionally been produced in Madagascar, the overall quantity of sorghum produced has declined significantly since the 1990s and remains relatively low, despite multiple efforts to reintroduce the drought-tolerant cereal crop across agricultural lands. USAID-Madagascar is committed to a better understanding of the opportunities presented by sorghum cultivation and marketing in Madagascar and to further diversify existing farming systems in response to the environmental and production challenges that smallholder farmers and the larger agricultural sector are facing.

With this interest in a shift towards increased sorghum production in Madagascar in response to both environmental and economic concerns, there is strong recognition of the need for a consistent and profitable market to ensure the long-term income and food security for sorghum producers. Driving market demand and developing a “pull” effect to ensure value creation are priorities, as is a comprehensive understanding of the available sorghum varieties that are well-adapted to Madagascar’s agroecological zones and exhibit crucial end-use characteristics.

Recent investments in commercial poultry production in the country present a compelling possibility for value chain development aimed at sorghum production for poultry feed. There are also urgent needs for reliable, high-quality feed ingredients for the broader livestock sector. However, the complex nature of these value chains, coupled with a general lack of sorghum performance data in Madagascar, establishes the need for a comprehensive value chain assessment to help determine both feasibility and next steps. Such an assessment is imperative both in understanding the existing challenges and opportunities, along with forecasting potential barriers and sector development.

To better position its planning process for the buildout of strategic partnerships and broader investment in key entry points in Madagascar’s sorghum value chain, USAID-Madagascar contracted with the Feed the Future Innovation Lab for Collaborative Research in Sorghum and Millet (SMIL), located at Kansas State University, to undertake the needed value chain assessment. The results and recommendations from that initial assessment are presented in this report.

Assessment goal

To comprehensively assess the opportunities for and barriers to the strengthening of a sorghum production value chain for poultry production in Madagascar with the purpose of increasing the capacity of the commercial poultry sector while simultaneously creating market and income opportunities for Malagasy cereal farmers facing serious production challenges presented by climate change and local environmental degradation.
Areas of investigation

To assess the existing opportunities, barriers, and potential challenges of the enhanced development of a sorghum production value chain for poultry feed, the following areas were explored through existing data, resources, and on-the-ground interviews and field visits:

1. Determination of sorghum production potential
2. Identification of locally adapted varieties and the potential for introducing other improved varieties
3. Assessment of local poultry production trends and opportunities
4. Investigation of sorghum transport feasibility and supply chain routes
5. Assessment of opportunities for direct contracting between sorghum and poultry feed producers
6. Establishment of network of key players for value-chain partnerships

The team for the sorghum value chain initial scoping visit included:

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Section 1: Sorghum production potential in Madagascar

Summary

There are several avenues that could positively impact sorghum production potential in Madagascar. These can be divided into two very general categories: environmental considerations and farm-level interventions. As an overview, Madagascar has agroclimatic conditions favorable for growing sorghum, and it is possible to see sorghum planted in traditional maize areas. Regardless of sorghum’s strong adaptation to water-limiting environments, drought remains a concern, however, and so does the low soil pH found commonly across multiple field sites visited within the country. Securing access to water and common soil amendments will go far in creating quick positive outcomes for sorghum producers, both commercial- and subsistence-level.

There are areas of opportunity for all levels of farms, from the large commercial enterprise to the small subsistence farm. The existing commercial farms in Madagascar can lead efforts in training and technical support for improved production techniques as well as opening value-added market opportunities. It may be possible for small farms to reach a greater level of success if commercial seed companies can introduce new, improved seed for adaptation testing and they can observe good production practices. In addition, commercial farms could be a source of quality seed for subsistence farms from successful introductions. Education and access to improved climate-smart farming techniques can assist subsistence farmers, especially mechanization, inputs, and storage equipment. It may be possible for farmer cooperatives or other organizations to pool their resources for needed inputs and equipment.

Finally, it is clear that there is sorghum processing capability within Madagascar. However, visits to other processing units on the continent would be prudent. This could be facilitated by the Sorghum and Millet Innovation Lab (SMIL) by leveraging existing networks and relationships already in place across both West and East Africa.

Initial observations

As part of the initial Phase I scoping visit (October – November 2022), team members visited both commercial-scale operations and subsistence-level farms in different regions of Madagascar, including the west, southwest, far south and south-central regions. The needs of commercial-scale farms and the opportunities they present differ substantially from those for subsistence-level farms; commercial operations in Madagascar use modern farming practices that would rival many in the United States or in Europe, while subsistence-level farms suffer from a severe lack of the most basic of inputs, including improved seed, fertilizers, and production implements. Regardless of these stark contrasts in production capacity, it is imperative to address both commercial and subsistence farms, because they both have potential roles to play in responding to Madagascar’s overall food security and economic development challenges.

Commercial-scale production

While conversations with various actors in the agricultural sector revealed the existence of small- to medium-scale commercial producers (estimated at around 30-50 ha per operation), two major commercial-scale production companies were mentioned regularly in discussions and appear to be two of the largest operations in the country.

Tozzi Green

The first commercial-scale farm visited by the specialist teams, Tozzi Green, is an Italian-owned company that farms in south-central Madagascar, near Satrokala. Historically, the farm’s primary production has been maize and essential oils; however, drought years have placed significant strain on maize production, leading farm management to consider more drought-tolerant crops such as sorghum and millet.

Maize and sorghum planting at Tozzi Green begins in November, and the sorghum they grow currently is a white hybrid imported from Lidea Seeds in Europe. This practice is not set in stone, however, as representatives say the farm is willing to grow any color of grain sorghum, provided the appropriate market exists. Hybrids are non-tannin, and most production is highly mechanized. While their commercial fields implement dryland farming, Tozzi Green tests varieties under irrigation in small plots prior to introducing them into commercial production. The farm receives an estimated 500 mm of rainfall during the growing season and generally practices minimal tillage.

Tozzi Green has a considerable amount of on-farm grain storage and can sell when grain prices are high. Markets are plentiful, and they indicate that they have no problem selling their sorghum grain. Because of its large quantity of product,
Tozzi Green is a key supplier to larger commercial end users, including in-country livestock feed companies LFL and AGRIVAL, among others. Interviews on the farm indicate an interest in switching to growing grain sorghum, as periods of drought during the growing season have led to poor maize yields. For example, the 2021 grain sorghum yield was 3.5 ton/ha compared to maize at 2.8 ton/ha. Tozzi Green also has relatively consistent access to inputs, including quality fertilizer, lime to raise soil pH, and access to pesticides and herbicides. Further analysis, particularly on micronutrient levels, was recommended by the specialist team’s soil scientist to further maximize yield potential of the farm. Experience at Tozzi Green with sorghum is limited, and they indicated that technical expertise assistance would be welcome, including recommendations for herbicide and insecticide use and other mechanized large scale production techniques.

Since its establishment in the region, Tozzi Green has invested substantially to provide opportunities for local community residents, including employment, health care, childcare, and education. It views the company’s social responsibility as a high priority and is committed to implementing a mechanism that benefits local populations while achieving a profitable sustainable production model.

**AGRIMA**

The specialist team also visited AGRIMA, a South African-owned company based in Sakay, Madagascar, approximately three hours west of Antananarivo. AGRIMA’s headquarters is a seed multiplication facility previously operated by the National Center for Applied Research on Rural Development (FOFIFA). AGRIMA was once part of the INVISIO group but has since broken off as a standalone company.

In addition to its own agricultural production, AGRIMA also is a key seed multiplier for numerous actors, including the Malagasy government and Catholic Relief Services (CRS), which distributes sorghum seed in the far South region. The majority of AGRIMA’s sorghum seed has been the open-pollinated variety MACIA from Capstone Seeds in South Africa. Released in southern Africa in the 1980s, this ICRISAT-developed variety is considered high food-grade quality sorghum. However, AGRIMA also has been producing other varieties of sorghum seed as needed, in addition to maize and other cereal crops. Furthermore, they recently have hand-collected local sorghum samples to begin testing and trialing these local varieties to learn more about the existing adapted genetics. AGRIMA primarily uses the Sakay location for seed multiplication purposes, though they are working to expand their commercial production both locally and in other regions of Madagascar.

One strategy for expansion is through additional commercial production activities in the west of Madagascar, near Maintirano. Rainfall in this region is plentiful and water supply does not appear to be the reason for AGRIMA’s interest in planting sorghum rather than maize. However, sorghum does appear better suited to other current and potential areas of production for AGRIMA. They report maize yields at 10 ton/ha, and although representatives from the farm did not report their sorghum yield, based on reported maize yields, 8 ton/ha sorghum should be possible. Currently, AGRIMA is testing nine maize and sorghum varieties a year. Like Tozzi Green, AGRIMA relies strongly on agricultural inputs, including fertilizer, pesticides, and herbicides.

AGRIMA has partnered with Sahanala, an NGO working directly with 4000 subsistence farmers in the region. Sahanala provides seed, equipment, fertilizer, technical support, and market access to local maize farmers and is currently building out facilities for further processing into higher-value end products. AGRIMA provides technical backstopping to those farmers to help them implement commercial-level production capacity, while also building their own commercial production in the region. Much like Tozzi Green, AGRIMA has a strong sense of social responsibility that is foundational to their operations, and they are constantly working to identify opportunities that are mutually beneficial for their company and local farmers and populations.

**Subsistence-level Farms**

The team visited multiple farms in the far southern region of Madagascar, near Ambovombe, Berenty, and Tshihombe, as well as in the southwestern region, near Menabe/Morondava. Severe drought and climate change has affected much of the South over the past several years, resulting in significantly diminished crop production. Because of this and other reasons, farmers have migrated from the South to other regions farther north, including to Morondava, where rainfall and land are potentially more plentiful.

All subsistence farms visited faced many of the same constraints resulting in highly limited production capacity for these farms. These included repeated unpredictable rainfall patterns, a severe lack of improved seed, inadequate access to fertilizers and other inputs, acidic and degraded soils, lack of mitigation options for fall armyworm infestations,
insufficient knowledge or access to improved techniques. While numerous efforts exist to try to address these constraints, those efforts are limited in scope when compared to the overall need.

Both the Technical Agroecological Center of the South (CTAS) and CRS are making efforts to supply quality seed to subsistence-level farmers. CRS provides seed to farmers via a regional network of seed vendors: they provide farmers with vouchers for a variety of staple crops, including maize, sorghum, millet, local pulses, cover crops, and tubers. In 2022, CRS contracted with AGRIMA to grow sorghum seed. The variety produced for distribution was MACIA.

CTAS is a national NGO dedicated to the production and dissemination of locally adapted crop variety seed to smallholder farmers. CTAS also provides technical assistance to farmers and has coordinated farm demonstrations on techniques to improve crop yields. One such demonstration, referred to as an “agroecological block” uses pigeon pea as windbreaks that are placed approximately 10 m apart to protect crops from the annual winds that can, at times, be extremely destructive. Sorghum, maize, groundnut, sweet potatoes, cassava, and other crops are then grown between the windbreaks. Additionally, some of the leaves and other organic matter from the pigeon pea plants are used to help restore soil health. These types of activities make CTAS an important source of inputs and technical knowledge for farmers and a learning context for replication in the South through other agricultural development programs.

**Current challenges**

In general, Madagascar faces several challenges when trying to amplify its sorghum production potential. These include the following:

- When examining the idea of sorghum production potential, it is important to note that there is currently no sorghum breeder at the National Center for Applied Research on Rural Development in Madagascar (FOFIFA), and any other work being done at the center on sorghum is sparse. Additionally – according to FOFIFA’s current model of activities – the locations in the country most suitable for sorghum production are also the ones with the weakest FOFIFA research presence.

- In general, the team noted a sorghum seed shortage and a lack of varietal diversity in the sorghum planted at the sites initially visited. In particular, subsistence-level farmers lack access to quality seed, as seed production is highly limited throughout Madagascar. Additionally, farmers indicated that they are “more accustomed” to maize than sorghum, and that sorghum is more difficult to process.

- Environmental/climate challenges will affect sorghum production potential in the country. Intense deforestation likely contributes to the impacts of drought, and environmental deterioration within Madagascar is ongoing. Drought can still pose a significant risk, even for a resilient crop like sorghum, which may discourage investments that could be lost if the crop fails to produce.

Additional complex issues were noted during the scoping visit. These issues were common across both commercial-scale operations and subsistence farms though some were region-specific:

**Soil pH**

Although information on soils is limited so far, a general picture is emerging. A soil pH of 5.5 is considered the minimum for growing sorghum or maize in the U.S. Most soils tested during the initial visit to Madagascar measured at or at many sites, significantly below this minimum pH level, indicating a serious potential problem with acidic soils.

At Tozzi Green, for example, soil pH levels begin at approximately 5 but soon drop to as low as 4.2 after six or seven years of production. To combat this, the farm is beginning a program using applied lime to raise soil pH to an acceptable level (≥5). AGRIMA also reports that soil pH is low, but not as low as levels reported at Tozzi Green or by growers in the South. They are applying dolomite to increase soil pH.

Subsistence-level farms in the south and southwest regions also have poor and degraded soils with little to no access to a reliable source of lime or other products to mitigate the low pH levels. Farmers report that soils below 5 pH are common, but observations during the initial visit indicate that soils may be better in the far South, presenting the potential of better production in the presence of reliable rainfall or with irrigation.
**Fertilizer**

There is great need for appropriate and accessible fertilizers such as sulfur, zinc, and boron, because they target anticipated micronutrient deficiencies in the degraded soils currently present across the southern regions. Significant macronutrient deficiencies in potassium were also noted. Interestingly, during visits to Tozzi Green, it was observed the amount of applied fertilizer was higher than what would typically be used in U.S. commercial production for a similar yield goal. However, extra application may be necessary due to the soil’s low pH. They reported that obtaining good quality fertilizer is an issue. Increasing soil pH would go a long way in solving at least some of the fertilizer issues. Subsistence-level farmers’ use of inputs that would increase yields and improve water use in dry years is almost non-existent. They lack access to quality fertilizers in the quantities needed. Under current potential sorghum yield levels (which is without inputs), farmers are unlikely to produce a meaningful surplus and therefore have nothing to sell at market for an increase in household income.

**Pests**

Subsistence-level farmers in particular report that, in addition to other issues limiting their grain production, insects are an issue, with fall armyworm being particularly destructive. Subsistence farmers lack insecticides and, in some cases, the equipment to apply insecticide. This gives them almost no defense against these pests. Commercial-scale producers report sometimes having to spray their crops multiple times a year to control fall armyworm, which is both undesirable and expensive. AGRIMA did note that they had fewer problems with fall armyworm on their sorghum than on their maize, though the reason for this is unclear. One possible theory was that fall armyworm preferred maize and therefore concentrated on those plants instead of migrating to the sorghum. It could also be related to the planting date of each crop.

**Transportation**

Outside of Antananarivo and the nearby regions, the road system in Madagascar is highly underdeveloped (see Section 4: Feasibility of Sorghum Transport and Supply Chain Routes). The lack of easily navigable roads substantially hinders the ability to move inputs into the more remote and challenged regions and makes it very costly to move any products into more highly populated areas. This is a notable barrier to any development of market linkages in and out of these regions. Most exchange of goods, therefore, needs to occur locally, or higher prices must be paid to cover the cost of transport. In addition, the difficulty of moving goods overland means that both farmers and processors are highly dependent on the services of collectors, who are notorious for taking a generous cut to fund their operations. This results in low prices for farmers and high prices for end users.

Some argue that additional modes of transportation should be explored. For example, AGRIMA reports that transportation over land is difficult to their Maintirano location, but they have plans to expand access using existing ports that allow them to ship supplies in and grain out. They assert that water is a more efficient way to transport goods around the country. This alternate transportation method may be deserving of greater attention.

**Corruption**

While far from being sorghum (or even agriculture)-specific, the high prevalence of corruption in Madagascar was a commonly discussed challenge and a barrier to the success of any development or business-related initiative. Contacts interviewed regularly cited the standard practice of “skimming” that occurs at every level of any project as money is transferred between departments and organizations. One farmers’ group in the South lamented the disappointing performance of countless development and aid "projects" in the region over the years. The group’s president explained that any money originally awarded from a large funder was frequently syphoned off at each administrative step, leaving only a small fraction of the total funds to be delivered to the farmers on the ground. The frustration about this system-wide corruption was apparent at all levels.

**Insecurity**

In addition to corruption, another societal-level challenge frequently encountered during the scoping visit interviews was a fear and frustration around high levels of insecurity, especially in rural areas. This insecurity seems to be heavily centered around cattle theft, which is particularly destabilizing in a country where cattle not only represent economic activity but are also a valuable conduit for wealth and social status in certain regions. These thefts leave many farmers without animal traction to work their fields, and “bandit” attacks on villages at times deteriorate into extreme violence and even death. The cattle theft network appears to be a highly organized one, with stolen cows being trucked miles away to slaughterhouses and sold under falsified paperwork.
Questions for further assessment

- How much potential benefit does sorghum truly represent as compared to maize in the drought-stricken regions of Madagascar? In which areas does it make sense to push for increased sorghum production and utilization in place of maize?
- Do seedballs developed under the SMIL program in Niger offer a profitable agronomic option to dryland farmers?
- Could Tozzi Green serve as a quality seed source for subsistence-level farmers in the South and other regions of Madagascar? Could AGRIMA’s role in providing seed for subsistence-level farmers in the South and other regions of Madagascar be expanded?
- Could Nucleopolyhedroviruses (NPV) be used to control fall armyworms (*Spodoptera frugiperda*) for both commercial and subsistence farms?
- In places where water is available or can be supplied, can we analyze which farming practices will give the greatest return on investment? How can judicious amounts of fertilizer decrease the risk to drought where water is limited?
- A major limiting yield factor is low soil pH. How can quality lime or other pH-raising material be sourced and distributed to subsistence farms? How can fertilizer formulations be designed in consideration of these pH levels? What are key micronutrient specific fertilizers that could boost yields in these low pH soils?
- The agroecological block concept being promoted by CTAS is promising, but it needs intense efforts to diffuse it widely. It would be more effective if combined with inputs – such as fertilizers and either crop protection products or integrated pest management (IPM). Can we further explore how to optimize this system in a way that is achievable for local farmers?
- A better understanding of the soil profiles and deficiencies across regions is needed. What macro- and micronutrient deficiencies are present? What is the most efficient way to address these to obtain maximum production at the lowest cost possible?
- Where will sorghum seed be multiplied, and how can the seed system be strengthened to provide better management and introduction of new genetics into the country?

Key opportunities identified for sorghum production potential

**Climate**
Madagascar has agroclimatic conditions favorable for growing sorghum. It might be possible to see sorghum planted in traditional maize areas due to new genetics, better land use policies, and increased access to quality fertilizers. Erratic rainfall in areas that have historically seen high rainfall may also create an environment where sorghum production is more acceptable. It would also help spread the risk for Madagascar if there are crop failures (such as maize) in other regions.

**Water**
Although the climate can be favorable, drought remains a concern; therefore, water resources should be harnessed where available. Sorghum producers with ready water sources (e.g., riverbeds, shallow groundwater, etc.) experience a mitigated drought risk, which in turn encourages investments in improved production techniques. Where water is used for sorghum, the costs of water should be considered, and input packages must be in place to maximize the value of the available water resource.

**Soil**
Raising the soil pH to 5.5, or even 5.0 at some locations, would have an immediate impact on yield by increasing root growth and greatly improving nutrient availability. Although there is no easy fix for the low pH of the soil, the cheapest and most common soil amendment to correct this issue is ground limestone (lime). Sourcing lime and creating a distribution pathway should be a priority. Providing better fertilizers for commercial farmers will result in quick positive outcomes and will likely also create the opportunity for better and more balanced fertilizers for smallholders.
**Processing**

Although there is sorghum processing capability within Madagascar, visits to other processing units on the continent would be prudent. This could be facilitated by the Sorghum and Millet Innovation Lab (SMIL) to leverage existing networks and relationships already in place across both West and East Africa. These professional exchanges would offer the opportunity for small- to medium-scale processing units to share knowledge and adapt concepts to local contexts. For subsistence-level farmers, a common complaint was the difficulty in dehulling and/or grinding sorghum. Sorghum production could be increased by sourcing small mills or other equipment that would make processing of sorghum grain easier.

**Commercial Farms**

Farms like Tozzi Green and AGRIMA can lead the efforts for improving sorghum production by providing training and technical support for improved production techniques as well as opening value-added market opportunities. The key to success will be linking commercial operations to smallholder farmers, but it is still unclear if this can be done on a large enough scale. Some potential models of this type of intervention already exist through the activities of groups such as Sahanala and LFL Agri and could be replicated at a broader level. Tozzi Green and AGRIMA have the knowledge, capital, and labor force to grow and produce sorghum. Consideration should be given to partnering with them to provide this service for subsistence farmers.

There are also additional opportunities to support successful sorghum production at commercial farms in Madagascar. They include:

- Facilitating a relationship between Tozzi Green and U.S. seed companies to test OPV and hybrids for use in Madagascar. For example, Richardson Seeds in the U.S. already has been introduced to the Tozzi Green farm manager. As a result, plans are being made to import both grain sorghum and forage sorghum varieties for testing at Tozzi Green.
- Considerations should be made to send commercial farm personnel in sorghum management to the U.S. or other countries involved in commercial sorghum production to observe production practices. Another possibility would also be to send a U.S. seed company representative to commercial farms within Madagascar to advise on hybrid selection.
- Facilitating a relationship between Tozzi Green and AGRIMA with SMIL’s national partners and seed system networks in West and East Africa. Imports of improved sorghum seed varieties from SMIL national partners in Senegal and Burkina Faso is in process to support initial adaptation studies.

**Subsistence-level Farms**

To improve the potential for subsistence-level farmers, there are some steps that can be made to improve the supply of quality seed.

- The system that CTAS uses appears to be working, at least on a limited scale. However, their ability to provide consistent quality seed is questionable and could be improved by providing modern equipment (small tractors, planters, etc.) and cleaning and storage equipment. These producers would also benefit from training in how to effectively implement a seed increasing system.
- Continue and accelerate the formation of farmer organizations or coops that could pool their resources to buy needed inputs as well as help to market their grain. They could benefit by cross-training with other African farmers’ associations in sorghum-producing zones, such as in Niger.
Section 2: Identification of locally adapted sorghum varieties and the potential for introducing other improved varieties

Summary

There are two well adapted varieties of sorghum currently grown with regularity in Madagascar, but there is great need for a more highly developed system where other varieties are tested and brought to market, both for commercial-scale and subsistence-level use. There is acknowledged interest and demonstrated capacity from both Tozzi Green and AGRIMA for testing different varieties. This can create benefits for any farm size or type, as both commercial farms asserted that they would be open to testing varieties targeted to commercial-scale production as well as subsistence-level production.

Members of the scouting team also noted the opportunity for the future development of a sorghum-focused research center within Madagascar with a primary purpose to test new sorghum varieties. The center's initial focus could be on open pollinated varieties and could potentially serve to house a much-needed improved gene and seed bank. As part of this effort, the center could also screen both open pollinated varieties and improved hybrids from various international organizations and from private companies. The second purpose of this center could be to increase seed for further testing with farmers and cooperatives.

Initial observations

The production of sorghum in Madagascar has seen a significant decline over the past three decades as maize has replaced it as the main crop of choice in many regions. At the same time, government-level investment in research and breeding of sorghum varieties has been minimal. Consequently, little is known about the distribution and genetics of the sorghum varieties currently grown in Madagascar, nor about what other existing varieties may be well suited to Malagasy requirements and environmental conditions. This is an area of pressing need for additional research and exploration. Due to differences in production realities and potential end-use goals, the differences in varietal needs between commercial-scale production and subsistence-level production are distinct.

Commercial-scale varietal needs

Visits to large-scale commercial producers Tozzi Green and AGRIMA demonstrated the need for alternate sorghum varieties better suited to more intensive, input-driven production aimed at maximizing yields. Tozzi Green, a commercial farm in south-central Madagascar near Satrokala, currently grows a non-tannin white hybrid imported from Lidea Seeds in Europe. The quantities they produce remain limited for the time being, but their target market is livestock feed. AGRIMA is another commercial farm, based in Sakay (approximately three hours west of Antananarivo). The majority of AGRIMA's sorghum seed has been the open-pollinated variety MACIA from Capstone Seeds in South Africa. This variety was developed by ICRISAT in the 1980's and is considered high food-grade quality sorghum. However, AGRIMA also has been producing other varieties of sorghum seed as needed, based on government and NGO requests for aid and development assistance. AGRIMA's most likely target market for sorghum production will also be livestock feed. At this time, both Tozzi Green and AGRIMA are aware of the need to test new varieties and are doing so, at least on a limited scale.

There are no known local sorghum varieties grown on a large scale. As noted, Tozzi Green has an established relationship with Lidea Seeds in Europe and plans to test some of their hybrids in the upcoming year. AGRIMA reports that they primarily have tested African varieties, especially those sourced from South Africa, and will continue to do so. AGRIMA has also recently been hand-collecting local sorghum samples to begin testing and trialing these varieties to learn more about the existing adapted genetics.

Commercial scale production includes improved access to inputs, mechanized techniques, and a strong target on the livestock feed market. As a result, commercially targeted varieties must be highly responsive to fertilizers, well-adapted to the low pH of Malagasy soils, drought resistant to withstand the increasingly erratic rainfall patterns, consistent in height and standability for harvesting ease, low- to no-tannin for feed requirements, and preferably tolerant or resistant to local pests.
Subsistence-level varietal needs

Varieties that are well adapted for subsistence-level production will likely exhibit some differences in characteristics from those varieties that are better suited to commercial-scale production. These include adaptability to hand-harvesting and cultivation, lack of access to fertilizers and pesticides, and the presence of acidic soils with few options for farmers to raise pH levels. These varieties will also require standability to resist heavy winds (particularly in the South), resilience in times of erratic rainfall, and resistance to high pest pressure from the fall armyworm and others.

Currently available varieties and seed stock

The team’s initial visit included time spent across several small production areas in the far south of the country as well as the southwestern region. Sorghum was being produced primarily for household consumption only – little surplus was observed which meant that market availability was limited. Knowledge about available varieties was scarce, but only two varieties were discussed with any frequency. The first of these was MACIA, a food-grade variety that is a white dwarf and open pollinated sorghum. The second was Rasta, a local open pollinated variety. Of the two, MACIA has been promoted by the Minister of Agriculture in Madagascar and was heavily produced and distributed in 2022 by AGRIMA at the request of Catholic Relief Services (CRS) for development assistance purposes in the South. MACIA’s performance data in the context of subsistence-level production does not appear to have been collected, but anecdotal accounts from local farmers indicate that its performance was satisfactory.

Rasta sorghum appears to be the preferred local variety in the South and is primarily produced by the Technical Agroecological Center of the South (CTAS), a regional NGO making efforts to supply quality seed to subsistence farmers. Detailed information about Rasta is limited, but it is a medium-height white variety with a particularly open panicle with awns. Some individuals have asserted that this open panicle helps protect against bird attacks; however, it is unclear if this is accurate. CTAS uses a seed multiplication model of partnering with farmers to produce the 2nd generation seed which is collected for distribution. This presents high potential for cross pollination and genetic degradation, so the consistency of Rasta seed being planted across farms remains questionable. CTAS did indicate that they keep a seed supply of four different types of sorghum, but Rasta was the only variety they discussed in detail.

While FOFIFA maintains parent stock of sorghum seed for the entire country’s needs (the national and regional catalogs currently list 37 different varieties), CTAS and AGRIMA appear to be among the largest seed producers in the country. They are key actors in responding to the questions around the best varieties available to match local farmers’ needs.

Current challenges

Multiple challenges currently exist regarding identifying the best sorghum varieties for the Malagasy context, but these challenges are all surmountable with the proper investment and action:

- There is a limited understanding of the currently available varieties in Madagascar. While organizations such as CTAS and FOFIFA have access to the core data regarding these varieties, more efforts are needed to clearly categorize their genetic profiles, as well as the purity of the lines.
- The national agriculture research system (NARS) remains weak, particularly as it relates to sorghum research and breeding, as well as its ability to be responsive to regional needs. While the team members at FOFIFA are enthusiastic and welcome partnership opportunities, they are operating on highly limited financial and staff resources.
- Another hurdle is in identifying outside varieties and testing them for their adaptability to different regions within Madagascar. There are few linkages that exist across the Malagasy systems and those outside the country as they relate to sorghum. Much effort is needed to build these networks to facilitate the exchange of information needed for varietal testing.

Providing quality seed of any variety to subsistence farms is a challenge. Efforts should be made to improve the current systems or to introduce an alternative. Working with the commercial farms to provide seed to subsistence farms should be explored further to insure foundation seed for further multiplication and for final product.
Questions for further assessment

The following high priority questions as they relate to varietal adaptation should be investigated when considering the next steps to further develop the sorghum value chain in Madagascar:

- What existing varieties – both across Africa or elsewhere in the world – have the potential to respond well to Madagascar’s growing environments and end-use needs? What should be the strategy for introducing new sorghum varieties/genetics?
- What existing sorghum varieties from the SMIL network are available and adapted to Malagasy growing conditions, and could this be an entry point for strengthening FOFIFA capacity?
- What types of strategic investments are most needed in FOFIFA to build out its role in supporting and leading sorghum varietal development for future needs in Madagascar?
- Which key actors are the best placed to advance a sorghum varietal development system to meet current and short-term needs?
- What is the most effective approach to facilitating varietal development and identification systems in parallel to promote response to both the commercial-scale and subsistence level needs?
- Can pearl millet be introduced to subsistence farmers and serve a similar food role as sorghum, especially in the most challenging agroecologies?

Key opportunities identified for locally adapted sorghum varieties

While the two main varieties grown (MACIA and Rasta) may be well adapted varieties within the Malagasy context, there needs to be a more highly developed system where other varieties are tested and brought to market, both for commercial-scale and subsistence-level use.

Varietal testing

Both commercial farms that the team visited expressed interest and capacity for testing varieties, which makes this an opportunity that could be acted on quickly. Both have asserted that they would be open to testing varieties targeted to commercial-scale production as well as subsistence-level production. This makes their capacity a potential bridge mechanism to begin gathering varietal information while other system-level shifts are under development. Assistance should be provided to these farms to identify potential varieties to test from various sources, including from Africa, Europe, and the United States. While CTAS could also potentially test varieties of various origins, its testing capacity is more limited, and it expressed little interest in testing anything that is not an already available local variety. Participation in the SMIL network could jump-start this activity.

Expansion of sorghum research capacity

Another key area of immediate opportunity would be the development of a sorghum-focused research center within Madagascar, likely located in the South. The center’s primary purpose would be to test new sorghum varieties, with an initial focus on open pollinated varieties, and potentially serve to house a much-needed improved gene and seed bank. The second purpose of this center could be to increase seed for further testing with farmers and cooperatives. The center would also be responsible for managing the farmer cooperator seed trials in-country. This center would work in close partnership with FOFIFA (or even be established under the FOFIFA system) and CTAS, as well as other major actors.
Section 3: Assessment of Madagascar's poultry and livestock sectors

Summary

The poultry and livestock production industry in Madagascar is rapidly growing but remains highly fragmented between the formal and informal production sectors; the country has only a small number of large actors among the substantially more numerous smallholder producers. Thanks to the demand created by continuous population growth, coupled with increasing investments in livestock production by both private and international actors, there is significant opportunity for further development of the livestock feed sector and the sourcing of locally produced feed ingredients, including sorghum.

For sorghum to be adopted as a livestock feed ingredient, a constant supply of grain and a competitive price are crucial. Continued expansion of feed mill on-site storage, improved commercial production techniques, and direct contracting opportunities to help secure grain at an anticipated price can help livestock feed companies keep their production costs more predictable. In fact, representatives from two major companies in Madagascar indicated interest in using sorghum for feed if those two goals are met.

Initial observations

Cattle (Zebu) play a unique role in the Malagasy culture. While Zebu are widely utilized for traction as well as meat – including being processed by a new industrial-scale slaughterhouse owned by an INVISIO company, BOVIMA – they also carry great importance in the establishment of wealth and social status, particularly among ethnic groups in the southern regions. In certain areas, acquiring Zebu is akin to acquiring power, and individuals will spend their entire lives building up the size of their Zebu herds. Those herds will not be sold at market; instead, they will be slaughtered when their owner dies, the meat being used to feed the many funeral goers that travel to pay their respects over weeks or months, and the horns will decorate the tomb of the owner who passed. In that sense, Zebu do not serve the purpose of an economic tool, but rather that of a social bank account: one that is emptied of its wealth when an individual passes. This complex relationship with Zebu adds further challenge to national-level economic development and creates an additional variable to be considered when evaluating the country’s livestock sector.

Overall, Madagascar’s livestock sector includes beef, dairy cattle, pork, small ruminants (goats and sheep), poultry, and fish. Across exchanges with different partners, there was some interest noted by those linked to the dairy industry in using sorghum sileage as a viable forage alternative. However, it is the poultry sector that demonstrates the greatest potential opportunity for sorghum as a feed ingredient. This made it a dominant topic of discussion during the scoping visits and a major focus of this report.

Production and Consumption of Poultry Products

In 2019, the official estimated per capita consumption of chicken meat in Madagascar was around 3 kg (Figure 1), with a small portion coming from commercial production. Figure 2 illustrates the per capita meat consumption in Madagascar. Although beef and fish and seafood were categories with the greatest consumption per capita, poultry was ranked third, above both pork and small ruminants (sheep and goat). Despite the low consumption, a sustained increase in poultry meat production was observed over the last three decades. The poultry meat production for 2020 was estimated at 86,742 mt, equivalent to ~50 million birds slaughtered (Figure 2).
Per capita meat consumption by type, Madagascar, 2019

Source: Food and Agriculture Organization of the United Nations
Note: Data refers to meat ‘available for consumption.’ Actual consumption may be lower after correction for food wastage.
On the other hand, egg consumption in Madagascar has decreased over the last decades. According to the UN Food and Agriculture Organization (FAO), the official per capita egg consumption in 2017 was 0.65 kg, or approximately 11 large eggs. The reduction in per capita consumption could be a consequence of the accelerated population growth and an egg production that could not keep up with demand (Figure 3). As shown, the population in 1966 went from 5.34 million to 28.92 million in 2021. Figure 4 shows that egg production went from 10,290 t in the early 1960s to 22,461 t in 2020. To keep an average per capita egg consumption of 1.02 kg, the country would need to produce at least 34,699 mt of eggs per year.
Figure 3. Population growth and per capita egg consumption in Madagascar

Source: UN Food and Agricultural Organization (FAO)
https://ourworldindata.org/grapher/per-capita-egg-consumption-kilograms-per-year

Figure 4.
Egg production, 1961 to 2020

Source: UN Food and Agricultural Organization (FAO)
Note: Figures include eggs derived from all domesticated or farmed birds.
Current capacity and demand

The animal feed industry in Madagascar is very small. Based on initial observations, there appear to be only two major animal feed manufacturers, with four manufacturing sites in the country. These two manufacturers include Livestock Feed Ltd. (LFL) of the Mauritius-based Eclosia group and AGRIVAL of the Malagasy parent company, INVISO. It is important to note that these feed production facilities are reliable manufacturing mills that can produce high quality animal and fish feed. All animal feed manufacturers use locally produced maize and milling by-products (mainly from wheat and rice mills); they also use locally produced lime and salt. All other raw materials (e.g., soya meal, vitamins, minerals, amino acids, and other micro-ingredients) are imported.

Very little, if any, sorghum is being used in the feed industry, as Madagascar only produces an estimated 1370 mt of sorghum per year.

Based on the information provided by company representatives from LFL, AGRIVAL, Basan Group and WFP, we can estimate the following:

- The current combined commercial feed mill capacity in the Antananarivo area is ~10,000 mt per month.
- The approximate use of maize for animal feeds can be estimated at 60,000 mt per year.
- The current demand for sorghum for human consumption is ~2400 to 3600 mt per year.
- The potential demand for sorghum for human consumption is ~13,000 mt per year.

While sorghum remains a cereal crop of minor production importance in Madagascar, the country’s commercial and small poultry farmers could heavily influence the production and use of sorghum as 55-70 percent of the commercial chicken diet is composed of cereal grains. This (coupled with increasing uncertainty regarding sufficient maize production in Madagascar and importation limitations on maize due to non-GMO restrictions) points to the animal livestock feed sector as being a key potential market for sorghum production, particularly at a commercial scale.

Livestock Feed Ltd. (LFL) – Eclosia Group

One of the largest livestock feed producers in Madagascar, Livestock Feed Ltd. (LFL), is one of the components of a vertically integrated poultry production business based in Mauritius under the Eclosia Group (Figure 5). LFL provides balanced rations to their commercial broiler chicken farms (Avitech), contracted chicken growers, and small producers. Avitech markets their chicken in grocery stores under the Chantecler1 brand name. In addition to chicken feeds, LFL Madagascar offers swine and ruminant feed products through FarmShop stores. LFL has a high-capacity feed mill in the Ivato region (close to Antananarivo) as well as two other satellite locations. The total production capacity of their feed mills is about 65,000 mt, which means that they require approximately 38,000-40,000 mt of maize for their mills.

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1 https://avipro.mu/chantecler
LFL has depots in different regions where they have buyers who are in the field trying to source maize from small- and medium-scale farmers. Initial interviews indicate that they are very involved with these farmers and are trying to assist them with improved productivity and yields. This initiative, called LFL Agri, involves providing technical support through field agents, including agronomic consultations and contract production support services such as mechanized land cultivation to help improve farmer yields. LFL also sources some of its needed maize from commercial-scale producers, including Tozzi Green and AGRIMA.

LFL has indicated that it is interested in establishing direct contracting agreements with selected maize producers. However, this arrangement has only been piloted and multiple challenges have been identified, including farmers choosing not to fulfill their contract and selling on the market instead when price proves advantageous. This pilot model has since been adjusted to explore direct contracting with farmer cooperatives for a greater chance of contract terms being followed in full. This continues to be an interesting development worth following closely.

**AGRIVAL (INVISIO Group)**

The other of the largest livestock feed producers in the country, AGRIVAL, is part of a company made of affiliates that have invested into different agricultural entities including animal feed, inputs, and agricultural shops. AGRIVAL is part of a vertical integration structure within the INVISIO group. It produces feed for multiple species (poultry, ruminants, swine, and fish) and has a high-capacity feed mill in the Antananarivo area. The total production capacity of this mill is about 5000 mt per month, but they are producing half that at present.

The INVISIO group uses approximately 1750 mt of locally produced maize per year. They have significant storage capacity and buy maize from small- and medium-scale farmers in bags and have it delivered to the feed mill where it is stored in bulk silos. Interviews from the initial visit indicate that they could use 210-250 mt of sorghum per month, depending on the price and their success in integrating it into their feed formulas.
Informal poultry sector
While the two major livestock feed players identified were LFL and AGRIVAL, it is important to note that the poultry sector in Madagascar remains overwhelmingly smallholder, with an estimated 90-95 percent of all poultry produced at this level. While some of those producers source their feed through LFL or AGRIVAL, many also use farm-produced feed products or purchase other milled feeds of varying quality. For these producers, cost is frequently the number one barrier to using more or better feed products. Additionally, while some smallholders may be using commercially developed specialty broiler or layer chicken breeds, many continue to raise “gache,” or local breeds that are more adapted to the environmental conditions. These breeds frequently have a much lower productivity rate.

Smallholders also face other challenges. One of the most important is lack of access to appropriate veterinary care. Vaccines often require cold storage for transport, which can be highly problematic for those producers located in rural areas far from market access. Veterinarians are also few and far between in these areas, which means that smallholder producers are often working with a veterinary technician. The process is time-consuming and often inaccurate: when there is a problem, farmers contact a technician, who transmits the information to a veterinarian, who then passes recommendations back in response to the information received. In many cases, the veterinarian cannot diagnose problems in person, or lab results can take several days or weeks to be made available. The end result is significant loss in flock numbers.

Visits with the National Cooperative Business Association-CLUSA International to a small village in the west of Madagascar with numerous poultry producers demonstrated these problems firsthand. While this group of producers advanced production techniques as a part of NCBA-CLUSA’s business support activities, a recent occurrence of disease among the flocks had decimated their hens and chicks. They were still trying to recover from this loss and made a direct request for small coolers that could help ensure that the vaccines they bring back from market remain viable during and following transport.

Current challenges
In all cases, a stable and adequate supply of grain and competitive pricing are critical for the adoption of sorghum in animal and human foods, and concern for sorghum availability and price were of key concerns by all animal feed manufacturers when considering the option of integrating sorghum into their feed formulas. In addition, despite efforts to increase commercial poultry production, companies face multiple challenges.

Large-scale poultry producers
Taking into consideration the low purchasing power of the Malagasy population, price becomes a priority factor for consumers and a challenge for commercial poultry producers. During the initial visit, the cost of a frozen broiler chicken at the grocery store was ~18,000 Ar/kg, while the cost of fresh, unrefrigerated, chicken meat at the street market was 12,000 Ar/kg. Aside from VAT (which is required for grocery-sold chicken but not for market-sold chicken), other factors creating this price difference include: high ingredient prices (imported and local), consistently low inventory of local ingredients, increases in fuel costs, an unreliable energy system and water supply, and poor or non-existent transportation infrastructure, especially in the southern regions. These multiple challenges make it difficult for companies to deliver competitively priced products.

Small- and medium-scale poultry producers
Small- and medium-scale poultry producers share some of the challenges companies face, such as high input costs and poor infrastructure. However, one of the biggest challenges for small producers’ profitability is the health management of their flocks which are vulnerable to preventable diseases and increased mortality due to the lack of vaccines and veterinary services. As previously mentioned, many smaller-scale and backyard producers are relying on gache chickens of local breeds. While likely better adapted to certain environmental conditions, they also tend to have much lower feed conversion rates, implying a need for more feed (and therefore higher expenses) for each kilogram of end product.
Egg producers face most of the same challenges mentioned, but one of the most critical barriers for these farmers is transportation. Poor road conditions, which are very common outside Antananarivo, could significantly affect the viability of eggs by increasing broken and cracked eggshells, resulting in serious losses.

Future barriers

One of the biggest barriers to increasing sorghum demand by commercial poultry producers is the population's low purchasing power. In a price-driven market, achieving a competitive price for commercial chicken will be important to increasing poultry meat/egg consumption among the general population.

Another potential impediment to increasing the production of sorghum-based poultry feeds is the lack of feed mixing facilities located in the southern regions of the country where sorghum is the most likely to be produced. The road infrastructure is very poor in these regions and without significant investment in the road system, transportation costs for ingredients and finished feed products in areas outside of Antananarivo are likely to lead to feed prices that are simply too high for most poultry producers to be willing to pay.

Questions for further assessment

- How can Malagasy companies and the government help to make commercial chicken more affordable and therefore drive higher demand for the poultry sector?
- How can small-scale poultry producers move to medium-scale production? Is the key to improve access to inputs and training, or are other factors in play?
- What is the potential sorghum use in different regions? What is the demand for grains and animal feed in the South? Will expanding to these regions have any impacts on new developments for animal feed production?
- Is it possible for small- and medium-scale producers in the southern regions to have access to feed mixing facilities close to their operations? What feed mill model will be the most sustainable (e.g., large commercial vs. small/medium feed mill)?
- What are the cost structure assessments for milling sorghum for feed, and how will the pricing compare with maize? From initial discussions, it appears that the millers have no objections to replacing a significant percentage of maize with sorghum, but realistic sorghum vs. maize values must be provided to ensure buy-in.
- What are the reasons for the sustained reduction in per capita egg consumption in Madagascar? How can production and consumption by the population be increased?

Key opportunities identified for sorghum in the poultry and livestock sectors

In all cases, the availability of the grain (constant supply) and a competitive price will be critical for sorghum’s adoption as a livestock feed ingredient.

Feed mills

Feed manufacturers compete with numerous traders to purchase maize for their feed mills. These traders have storage facilities and are well-organized; they buy maize early in the season, store it, and then sell it later into the market at significantly higher prices. Continued expansion of feed mill on-site storage and direct contracting opportunities to help secure grain at an anticipated price point can help livestock feed companies keep their production costs more predictable.

Representatives from both LFL and AGRIVAL indicated an interest in using sorghum for feed if prices are competitive and grain is available. Specifically, LFL personnel expressed interest in testing low-tannin sorghum as a potential replacement for maize in poultry diets. It is important to highlight that maize or low-tannin sorghum can constitute up to 55-70 percent of the chicken diet formulation. If consistency can be assured for sorghum through improved and increased production, adoption by large feed manufacturers seems likely.
The existing market for feed continues to lag. However, this can be improved with smaller feed mills across numerous localities. Much can be accomplished with a 1-ton mixer and hammermill, for example, which could also open the potential of higher value markets for locally produced sorghum, even in more remote areas in the South and elsewhere. These small-scale mills are common in East Africa.

*Poultry and livestock feed*

Over time, sorghum production could help develop animal protein production in the southern regions, where sorghum yields and production potential are likely higher than maize and could provide a more reliable feed ingredient source.

AGRIVAL expressed interest in testing a 25 percent replacement of maize for low-tannin sorghum in poultry feeds. The conservative replacement rate does not stem from a concern about sorghum’s nutritional value, but rather due to concerns about feed color and chicken skin pigmentation. White or red sorghum varieties will change the feed’s typical yellow color and therefore may impact the resulting pigmentation of the animal skin and egg yolk (in the case of laying hens), which could have negative effects on consumer acceptance of feed and poultry products. However, AGRIVAL accepted that this could be solved by adding pigments to the feed and educating their clients; company representatives indicated that a slower transition from low to higher inclusions of sorghum could then be possible (cost and supply permitting). Representatives said that the mills could use up to 100 percent sorghum when it is fully available (depending on price).

*Animal production and exports*

Poultry and swine require starch in their diets, making low-tannin sorghum an excellent option. It is important to highlight that only low-tannin sorghum should be used in poultry and swine production. High-tannin sorghum varieties have a detrimental effect on growth and efficiency, and feed additives (enzymes) have not been consistent in reverting the negative effects of tannins.

Taking into consideration Madagascar’s rising population, an increase in animal production (commercial and medium scale) is expected. Consequently, the demand for cereal grains should increase. Using poultry production numbers from 2020 (Figure 2) and assuming birds were slaughtered with a 2 kg body weight and feed efficiency of 1.8 kg/kg, the amount of grain (ex. maize) needed to feed those birds can be estimated at around 100,000 mt, representing a significant opportunity for sorghum production - if that production achieves adequate quantity and quality to meet commercial sector needs.

In many instances, traditional poultry farming is conducted as a secondary activity with minimal investment. Depending on local customs and the availability and affordability of feedstuffs, families decide whether to feed grains (or grain by-products) to the birds. Providing inputs, technical support, and business management education could expand some small-scale producers to medium-scale, thus increasing the demand for grains (such as low-tannin sorghum).

The potential exists to feed an expanded number of livestock (Zebu cattle) and therefore increase beef exports. According to initial interviews, an abattoir located in the south (BOVIMA) is underutilized because of small livestock numbers, but if more roughages and feed become available, this could change. Additionally, interest from the dairy industry in alternative silage and forage options provides another key opportunity for sorghum to respond to the evolving needs of the livestock industry.
Section 4: Sorghum market barriers and opportunities

Summary

Sorghum transport and supply chain routes are essential for a successful and robust sorghum value chain. Poor transportation infrastructure in Madagascar is an obstacle acknowledged by everyone, at every level. It might be possible to circumvent this problem by establishing a network of smaller feed mills in the South to provide more immediate opportunity for local economic activity and feed availability. Subsistence-level farmers desperately need assistance to transport their products to market; it is possible that the formation of farmers’ associations or cooperatives could help ease this burden.

Opportunities also exist to support direct contracts between producers and animal feed millers. One such suggestion is to put a system into place for farmers to use sorghum as a barter trade to buy feed. In certain regions, this could promote sorghum production if poultry producers (who in most cases are also small-scale farmers) know they have a market for their sorghum.

Another important area of opportunity for sorghum in Madagascar is in food product development. While household use for subsistence level producers will be an important area of more immediate impact on nutrition and food security, the increased interest by larger food companies in integrating sorghum into their new product formulations presents the exciting potential for new niche and high value markets for commercial sorghum producers.

Feasibility of sorghum transport and supply chain routes

While sorghum may have the necessary characteristics to be a successful drought-tolerant alternative to maize and a high-quality animal feed ingredient, the development and buildout of a robust sorghum value chain will be highly dependent on the feasibility of supplying the desired quantities of sorghum to the target end users. This reality makes the overall transport and supply chain routes a priority area.

Initial observations

Most major food and feed manufacturing plants are in Madagascar’s central highlands near and around Antananarivo. During travel between site visits, it quickly became evident that the country has poor road and transportation infrastructure outside of this specific area (around Antananarivo) and between outlying regions.

Based on the Rural Accessibility Index, close to 17 million Malagasy rural residents are unconnected due to poor or non-existent roads. As expected, this limits both trade and the fair distribution of goods. Based on the assumption that commercial sorghum production would take place in non-irrigated areas with limited (or inconsistent) precipitation, then most of the activity will occur in the southern part of the country. Theoretically, a network of national roads connects the main cities in Madagascar to Antananarivo. However, due to road conditions, travel time is more than doubled – and even tripled - compared to typical well-paved roads (Table 1). Depending on weather, the specific transport vehicle, and other factors, travel times can far exceed the estimates listed below.
### Table 1. Route Examples (times and distances)

<table>
<thead>
<tr>
<th>Proposed Route</th>
<th>Distance</th>
<th>Estimated Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>RN-10 to RN-7 to Antananarivo</td>
<td>1113 km (Ampanihy to Tana)</td>
<td>more than 22.5 hours</td>
</tr>
<tr>
<td>RN-13 to RN-7 to Antananarivo</td>
<td>1012 km (Ambovombe to Tana)</td>
<td>more than 21.5 hours</td>
</tr>
<tr>
<td>RN-35 to RN-7 to Antananarivo</td>
<td>709 km (Morondava to Tana)</td>
<td>more than 12.5 hours</td>
</tr>
<tr>
<td>RN-34 to RN-7 to Antananarivo</td>
<td>511 km (Malaimbandy to Tana)</td>
<td>more than 10 hours</td>
</tr>
<tr>
<td>RN-1 or RN-1b to Antananarivo</td>
<td>563 km (Ambondro to Tana)</td>
<td>more than 9 hours</td>
</tr>
<tr>
<td>RN-2 to Antananarivo</td>
<td>353 km (Toamasina to Tana)</td>
<td>more than 8 hours</td>
</tr>
</tbody>
</table>

*Times and distances estimated by Google Maps*

In addition to road transport, Madagascar has a total of six ports with container terminals. Port locations are in Tolagnaro (south), Toliara (southwest), Toamasina (east), Mahanjanga (northwest), Nosy Be (north; in Nosy Be Island), and Antsiranana (north). There is also an unconnected railway system serving the east-central region and southeastern region (Figure 6). The East-central route has stations in Toamasina, Ambatondrazaka, Moramanga, Antananarivo, and Antsirabe. The Southern route stops in Manakara and Fianarantsoa.
Commercial-scale farms
While Tozzi Green, a company farming in south-central Madagascar, did not report any issues with moving their end-use product to market, AGRIMA indicated that ground transportation was of major concern. AGRIMA is located on the western coast, near the city of Maintirano, and their representatives stated that moving anything across country by land was “almost impossible.” Fortunately, they are located on the ocean with a port that allows them to ship grain out and necessary farm inputs in. However, AGRIMA is working to identify opportunities to process cereals locally to capture more value from the agricultural products and to keep the economic impact within the region and with local farmers.

It is important to anticipate that any increase in commercial-scale sorghum production will bring with it the need to move larger quantities of grain over a variety of distances, depending on the end use. It will be imperative to anticipate the potential logistical challenges associated with this to ensure the overall successful buildout of a sorghum value chain.

Subsistence-level production
Most subsistence-level sorghum production has less product to move over shorter distances, resulting in potentially less immediate consequences for their production systems. However, most subsistence farms will still find that moving supplies and inputs for their farming operations is a challenge. Additionally, if their production levels do evolve more toward commercial-scale production, farmers are likely to find market access decidedly limited due to transport challenges. This creates barriers to selling product and suppresses opportunities for accelerated market growth.
Current challenges

As previously mentioned, poor road conditions are a major challenge for transporting inputs from distribution centers to agricultural supply shops (such as FarmShop and Agrishop stores) and to farmers. Currently, the southern region of the island is very underserved by these suppliers, making viable transportation routes even more important for the populations in those areas.

Road conditions are the main challenge for transporting grain from farms to commercial feed and food manufacturing facilities and then on to the capital city. At this time, Madagascar sorghum production is 1,370 mt/year, and it is mostly consumed in the areas where sorghum is produced. There is a limited understanding of available storage for grain, but initial interviews suggest that storage is in short supply. Poor storage could result in the proliferation of mycotoxin-producing micro fungi and insects that compromise the safety and nutritional value of grains.

Questions for further assessment

• What concrete plans (from the national government, World Bank, or other entities) have been initiated to improve transportation infrastructure for southern Madagascar?

• Can the government, private sector, or cooperatives establish strategically located, well-designed grain storage sites?

• How can farmers in the South have better access to agricultural inputs in light of current transportation challenges?

• Are ports a potential alternative to move grain from the southern region to the capital city (i.e., via Toamasina Port)?

Key opportunities identified for responding to sorghum transport limitations

• While one of the companies expressed interest in building a commercial feed mill in the southern region of the island, it might be more efficient to establish a number of smaller feed mills in the South to serve livestock producers in the area. This would reduce the need to transport grains to commercial feed mills in the capital and provide more immediate opportunity for local economic activity and feed availability.

• To help subsistence-level farmers afford product transportation to larger hubs, support should be provided to them in the formation of associations and/or cooperatives to further organize their production logistics.

Potential for direct contracts between sorghum and livestock feed producers

Initial observations

Although a significant proportion of the grain purchased by animal feed companies is negotiated through traders and collectors, some are attempting to avoid the middleman and deal directly with farmers. LFL (Eclosia Group) and AGRIVAL (INVISO Group) both have been testing direct contracting arrangements with maize producers with mixed levels of success. LFL has multiple storage sites around the country where they can check basic quality parameters before transporting the grain to their more central manufacturing facilities. Both LFL and AGRIVAL state that they pay a fair price to incentivize future production; they estimate the payments based on the average regional production costs.

A similar model could be applied to sorghum to help ensure a consistent and predictable supply for animal feed companies which, in turn, will improve their confidence in sourcing sorghum as a primary feed ingredient. Grain producers in the Tsiroanomandidy zone, a major sourcing area for LFL, have expressed their interest in testing sorghum. However, they must be assured of a viable market for their product before they will commit to transitioning to sorghum in place of other crops. Direct contracts are a promising mechanism to mitigate the risk from both sides and facilitate the flow of product.
Current challenges

Most grain producers in Madagascar produce at the small scale or subsistence level, which makes it difficult to maintain quality standards, regular product collection, and proper in-farm storage. Many of these farmers are also resistant to direct contracts or have defaulted on contract terms when those terms were not perceived as beneficial for the producer (i.e., when market prices have risen, and they could capture more value by selling their product elsewhere). It could take years for companies to gain the trust of grain producers and achieve buy-in on the direct-contracting mechanism, while also ensuring that they are providing the most favorable terms possible to producers. Established models of accountability will also be necessary for companies to fully trust that producers will not default on agreed-upon terms.

Questions for further assessment

- How can companies and organizations gain the trust of grain producers and cooperatives to engage in a direct contract?
- Is the method used by companies to determine grain price appropriate?
- Is it possible for companies to eliminate the middleman when buying grains?

Key opportunities identified for direct contracts for sorghum production

Could systems be put into place for farmers to use sorghum as a barter trade to buy feed? In certain regions, this could promote sorghum production if poultry producers (who in most cases are also small-scale farmers) know they have a market for their sorghum.

Could direct marking agreements be established between feed companies and producers’ cooperatives to help ensure a stronger model of accountability, risk mitigation and confidence across the companies and farmers alike?

Food product development as potential market for sorghum production

There is clear potential for sorghum as a food ingredient for human consumption within Madagascar. While a primary focus is on household subsistence use for an immediate impact on both nutrition and food security, commercial-level applications in processed food products show great promise and opportunity. Food companies are actively looking for alternative starch sources (such as low-tannin sorghum) due to the increasing cost of imported raw materials and the limited availability of local maize, among other factors. For larger food companies, integrating sorghum into their new product formulations presents the exciting possibility for new niche and high value markets for commercial sorghum producers.

NutriFoods, an INVISIO group food product subsidiary, has launched a line of powdered products that could potentially use sorghum flour (such as porridges, soups, and food aid blends). The potential for sorghum-based food products is also being explored by JB, the consumer products division of the Basan Group. JB sees opportunity for including sorghum in the formulation of new baked snack goods formulations, such as biscuits and cookies, and plans to expand its portfolio to add more products that could include sorghum flour. They also expressed interest in testing the partial replacement of maize for sorghum in some of their existing products.

Current challenges

Currently, the food product development sector faces many of the same challenges as the animal feed sector when considering the integration of sorghum into their formulation: lack of overall supply, unpredictable availability, difficulty transporting of raw ingredients, lack of grain quality, and high sorghum prices.

The food product development sector also has additional hurdles to overcome in order to gain a stronger understanding of sorghum’s performance qualities in food products and consumer acceptability. Companies are only in the early stages of developing an appreciation for sorghum as an ingredient and some lack familiarity with varietal differences as they relate to nutrition, taste, and overall functionality.
Questions for further assessment

- What acceptability does sorghum have as a food product ingredient for consumers in Madagascar? How does this differ between those consuming sorghum at a subsistence level and those consuming it in a commercial processed food?

- Is it possible to introduce low-tannin sorghum as an alternative starch source in Malagasy households and food products?

- What sorghum-based commercial food products present the greatest opportunity for uptake in Madagascar?

- What locally adapted sorghum varieties have the best characteristics for food-specific use?

- Would food product development companies be willing to enter into direct contracts with sorghum farmers to assure a consistent, high-quality supply?

- How can the SMIL network and the expertise of West African food processors be tapped to develop the scale and scope for business activities in Madagascar, especially for small- and medium-scale enterprises? Is extrusion a useful tool for formulating highly nutritious instant porridge blends?

Key opportunities identified for sorghum-based food product development

The creation of linkages on both the large-scale commercial food sectors and the small-scale artisanal with comparable counterparts across the continent could serve to help catalyze interest and provide opportunities for cross-learning around both functionality and nutritional aspects.

Sorghum-based food product development in Madagascar could benefit from the facilitation of visits to facilities and training centers in other countries to acquire both technical knowledge and professional linkages. The SMIL program has an extensive network of food processors in West Africa that can stimulate ideas on product development.

Facilitating direct linkages between farmer cooperatives or commercial-scale producers willing to enter into direct contracts with food product development companies could help ensure a quality supply of food grade sorghum.
Section 5: Strategic partnerships for sorghum value chain development

Summary

There are specific opportunities to be gained from cultivating strategic partnerships to build out an active and robust sorghum value chain in Madagascar, from the private sector all the way to international NGOs. Specifically, the team noted a strong commitment within the private sector to social investment and helping household producers to succeed. Existing businesses within Madagascar can play a major role in the advancement of sorghum production if they include sorghum in their current and future product formulations. International actors will be able to positively impact infrastructure and other country-wide challenges to assist farmers to overcome existing barriers.

If a more comprehensive, sustainable development of the sorghum value chain is considered a priority moving forward, engaging major actors at all levels of the value chain will be a necessary next step. Fully understanding the interactions between these actors, and the strategic partnerships among them, is key to ensuring effective engagement at all levels (Figure 7).
Figure 7. Map of the key actors working within Madagascar (colored circles) and their influence on the current state of the sorghum value chain. Solid lines indicate a stronger influence, while dotted lines show secondary impacts.
Key private sector actors

Madagascar’s private sector has been key to the growth of the agricultural sector – a marked contrast to the government’s small public investment. Based on UNICEF Citizens Budget reports, in 2018 and 2019, the distribution of ministerial expenditures for agriculture were 408.4 and 507.9 billion Ar, respectively, representing 5.8 percent and 6 percent of the annual national budget. In 2020, the expenditure in the agricultural sector increased to an estimated 711.7 million Ar.

Moving forward, the private sector has a major role to play in advancing Madagascar’s productivity, establishing mechanisms to support smallholder farmers in building toward commercial-scale techniques and yields, improving access to inputs and new varieties, and driving demand for locally produced sorghum throughout the country.

Tozzi Green
Building out a sufficient sorghum supply of reliable quality and quantity is a major hurdle to the establishment of a stronger sorghum value chain in Madagascar. Tozzi Green, one of the country’s two major commercial-scale farms with large-scale cereal production, is located near Satrokala in the south-central region and has focused primarily on maize production in recent years. However, erratic rainfall encouraged Tozzi Green to begin exploring other, more drought-tolerant, crops, including millet and sorghum. It has already produced limited quantities of sorghum, which it has supplied to both animal feed and food product companies for testing and evaluation purposes. Tozzi Green’s capacity to produce a large quantity of high quality, consistent grain means it is poised to positively affect the supply of commercial feed companies with their needed quantities for a sorghum-based feed formulation.

Additionally, Tozzi Green has both the ability and the expressed interest in testing out new and improved sorghum varieties for Madagascar growing environments. Because of Tozzi Green’s strong research and evaluation capacity, it has advanced abilities to execute precise tests of many varieties under specific growing conditions. It has also offered to test varieties targeted to both commercial-scale production as well as those better adapted to subsistence-level production. This makes Tozzi Green a crucial potential partner to evaluate existing sorghum varieties in Madagascar’s dry southern climates and acidic soils.

AGRIMA
A common concern among nearly all groups initially interviewed is the available amount, cost, and quality of the seed supply. AGRIMA, one of the few large commercial-scale farms in Madagascar, is dedicated to the seed multiplication business and also holds government contracts for supplying seed to the national program. Their production and storage facility in Sakay has the potential for additional growth, making them important for the production and supply of high-quality sorghum seed. They have already been pivotal in maintaining sorghum seed in recent years of drought and should be looked at strategically in future seed system and varietal development efforts moving forward.

In addition, AGRIMA’s commercial production capacity of cereal grains is substantial, making it an important potential supplier of large, consistent quantities of cereals to the livestock feed market. AGRIMA’s ability to provide a reliable ingredient source makes it an influential player in livestock feed sector development, particularly in the case of sorghum, which is currently produced sporadically across the country. As part of their partnership with Sahanala, AGRIMA’s interest and commitment to providing smallholder farmers with the technical backstopping needed for them to adopt commercial-scale techniques is another attribute making them a major driver to the development of Madagascar’s feed and sorghum industries.

LFL (Eclosia) and AGRIVAL (INVISO)
Both groups are making efforts to attract new or to keep existing producers (livestock and grain) in business by providing inputs, technical support, and financial products to producers. The Eclosia Group supports animal production through Livestock Feed Limited (LFL), Avitech, and FarmShop. These businesses provide day-old chicks for meat production, pullets for egg production, balanced feeds, health products, equipment, etc. FarmShop offers workshops to educate producers on new techniques to increase production and efficiency; it has a network of 13 poultry technicians and three technicians for other species, each of whom serve multiple areas in Madagascar. LFL similarly provides technical support as well as access to equipment for grain producers to increase their production and maize supply. LFL also provides low-interest loans to grain producers for purchasing inputs and services to plant maize.

The INVISO Group, with their businesses AGRIVAL, Mabel, and Agrishop, takes a similar approach with the poultry and grain producers, but no financial products are offered. The company built a beef cattle abattoir in the south of Madagascar under the subsidiary, BOVIMA, which is now being considered for small ruminant meat production.
These companies play two significant roles. The first is in their potential influence on overall market demand for sorghum and other feed ingredients. With increasing demand for animal proteins to nourish Madagascar's growing population, LFL and AGRIVAL are poised to supply consistent and quality products to help meet that demand – if they can do so at prices that livestock producers and consumers are willing and able to pay. As the two largest players in the country's animal production sector, they represent the potential to move quantities of grain, and in turn, influence market opportunities for feed ingredient producers, including sorghum farmers.

Secondly, both LFL and AGRIVAL are positioned to lead the charge in building out mechanisms that help connect smallholder farmers and cooperatives to market and value opportunities. Both have begun making efforts in this area through technical support and input provisions. However, this model could continue to be built out in greater scale: both in assisting farmers to adapt their techniques from subsistence-level production to commercial-level production as well as contracting directly with farmers and cooperatives to help mitigate risk and ensure a sustainable supply of cereals into the feed mills.

Sahanala Madagascar
As a national non-profit association, Sahanala is focused on agricultural development and conservation and linking farmers to the market. One of their main objectives is capacity building within local communities through training and then integrating these stakeholders into a federation strong enough to face international markets. A strength of their organization is that they provide farmers with the opportunity to participate actively in the development of their locality and in the protection of their environment. By providing farmers with a more stable income and by teaching them practices such as organic farming and respect for the environment, Sahanala hopes to improve local communities sustainably.

Currently, Sahanala reports that they involve more than 12,000 producers, 94 associations, four federations and 12 regions. According to their business profile, Sahanala distributes annual profits to their members (50 percent), to farm associations (40 percent), and to federations (10 percent).

Although spices such as vanilla are the largest focus of their operation, maize is part of the Sahanala portfolio of products. This is mainly in the Maintirano District, where Sahanala supports eight associations and 750 producers. Although this is the only region where they support maize production, they are looking at other opportunities. Representatives agree that potential sorghum production would be most successful in the southern regions and in some northern regions.

Sahanala’s model involves partnerships with numerous international and multinational companies and organizations, including ADM, Rodelle, and others. This approach opens market opportunities for Sahanala’s farmers while providing a sustainable model that leverages outside funding sources for greater impact and outcomes that benefit all players. Sahanala’s model is one that is deserving of a closer look and possible replication in other sectors, particularly in the South.

Basan Group and NutriFoods
Two major food product companies, Basan Group and NutriFoods (INVISO group) have expressed significant interest in the opportunities presented by sorghum as a primary ingredient in their new food products. While the types of products offered by the two groups differ, both see promising potential in sorghum-based products – whether that be instant porridges, biscuits, or crackers - and are already launching product testing to explore new product development options. An expansion of sorghum use in the food development sector would not only represent a potential increase in quantities demanded, but it would also open the possibility of new markets for high-quality, consistent sorghum varieties grown for food use.
Major government actors

**Government of Madagascar: Ministry of Agriculture and Livestock**
As the national leader of the agriculture sector, Madagascar’s Ministry of Agriculture and Livestock occupies the unique position of providing leadership in setting national-level priorities that respond to the most pressing needs and promising opportunities for the Malagasy population. The Minister of Agriculture already has shown strong support for sorghum as an alternative to maize for smallholder farmers, particularly in the drought-stricken South, and has led efforts to promote sorghum’s cultivation and use across numerous communities. Continued efforts by the Ministry to help improve the accessibility of appropriate varieties, technical support, and end-use markets will be vital to the adoption of sorghum throughout the regions that can benefit from it most.

**The National Centre for Applied Research on Rural Development (FOFIFA)**
FOFIFA promotes agricultural research in Madagascar and focuses on crop, livestock, forestry, postharvest, and socioeconomic research. This national center collaborates with regional and international research institutes and networks involved in rural development issues in Madagascar. FOFIFA is widely involved in the country’s agriculture sector, especially regarding agronomic research, rice, forestry, production systems, animal health, and processing. They also have a network of laboratories in use.

Because of this, FOFIFA is positioned to take a leading role in the identification and development of locally adapted sorghum varieties with characteristics that fit both agronomic conditions and market/end-user needs. FOFIFA would also be well positioned to support the maintenance of national seed banks and the establishment seed system development strategy. However, FOFIFA’s current state leaves it unable to play this role. It is heavily underfunded with only a very small unit focused on sorghum research. Additionally, the overall system appears to be only modestly connected with the needs of remote areas far from Antananarivo and unable to respond to the diverse needs of the country.

In order for FOFIFA to take a strategic place in the development of a sorghum value chain, significant investment both in terms of resources and capacity building will be necessary. There is great potential for skill transfer and exchange using SMIL’s French-speaking network of researchers, seed system actors, women food processors, farmer associations, etc. in West Africa where SMIL has been building partnerships for more than a decade. Joining the SMIL network would provide a rapid track to increase operational capacity.

Non-governmental actors

**CTAS**
As the primary seed multiplier and a major technical support provider in the South, CTAS is another notable actor well positioned to influence the future of sorghum production in Madagascar. Because of CTAS’s extensive network and relatively sophisticated system of seed production, distribution, and sales, CTAS can serve as an influential player in the distribution of locally adapted sorghum varieties that respond to both farmer and market needs.

CTAS has an irrigated farm where they produce sorghum seed that is distributed to farmer multipliers to increase the seed supply. CTAS has a process to verify the quality of the seed it receives back from the multipliers, which appears to be primarily through the testing of seed germination. They also can test varieties at this irrigated site, though the infrastructure of the site shows significant limitations, and a number of trials displayed signs of severe bird attack. CTAS also applies a seed treatment and stores seed in 50 kg bags at a central location. That seed is provided to select farmers/vendors who distribute the seed locally at a price set by CTAS. The seed is stored in the vendors’ homes and is only delivered at the time of planting. Any excess seed is collected soon after planting to prevent it being sold for food. CTAS indicates that they maintain four sorghum varieties, but team members on the initial scoping visit observed only one (Rasta) being distributed.

It is important to note, however, that CTAS’s infrastructure currently remains limited, and this farm faces numerous logistical and environmental challenges that put into question the quality of seed produced. Their seed multiplication, while irrigated, frequently suffers from the realities of an outdated facility in desperate need of upgrades and staff resources. In addition, CTAS has shown little interest in exploring new or improved varieties, instead choosing to focus their time and resources on multiplying locally accepted varieties, such as Rasta. To play a central role in the development of the sorghum value chain into the future, CTAS will need to identify solutions to further develop their seed multiplication potential as well as being receptive to potentially new and improved sorghum from other locations and sources.
Tinone Association and similar farmer-led organizations
The Tinone Association, a farmer-led organization located in and around the Ambovombe-Androy region in the South, is a very active group under the progressive leadership of farmer Josoah Monja. This organization works in partnership with numerous development groups, including the CNFA Farmer-to-Farmer organization, and is both engaged and willing to try new techniques and approaches. This association, and other farmer-led organizations like it, have the potential of acting as catalyst communities in the startup of new market-based endeavors as well as serving as important hubs for the testing of technologies and the buildout of pilot projects. Because of the group’s existing experience with sorghum production and their progressive approach to improved techniques, the Tinone Association is well-positioned to be a significant part of the sorghum value chain in the arid southern regions.

Catholic Relief Services (CRS)
Catholic Relief Services (CRS) is a highly influential NGO and a major participant in all development and relief efforts in Madagascar. CRS is a very active participant in the supply of seed to areas in challenge or crisis, and as a result, they have become an important driver in the procurement and the distribution of seed across Madagascar, particularly in the South. That influence, as well as their understanding of the necessity of sorghum as an alternative crop for households facing drought and other production challenges, makes CRS a particularly important partner in the work to acquire needed seed supplies and to construct a more structured seed distribution system.

CNFA Farmer-to-Farmer
The CNFA Farmer-to-Farmer program in Madagascar links U.S. farmers and technical experts with Malagasy farmers, entrepreneurs, and businesses to leverage outside expertise for the growth and development of agricultural production in Madagascar. Through this mechanism, CNFA has established partnerships with numerous international organizations and a network of farmers to trial new technologies. In the past year, two sorghum production Farmer-to-Farmer exchanges were organized with experts based remotely in the U.S. and a two-week site visit in the South by Dr. Nofou Ouedraogo, a SMIL collaborator from Burkina Faso. Another example of this has been soybean varieties acquired and tested through a partnership with the Feed the Future Soybean Innovation Lab. This network of farmers with both the experience and interest in undertaking varietal trials in collaboration with CNFA presents an existing and established mechanism that could quickly be tapped into for trialing new sorghum varieties for their adaptability to the Malagasy growing conditions.

World Bank
The World Bank serves as an important partner in several agriculture-related development areas, both in terms of directly funding interventions and projects, as well as influencing government and international donor priorities in-country. The World Bank has already invested in key areas, including poultry and egg production units, seed production facilities, improved access to water points, and major road development. Perhaps even most relevant is their current desire to invest heavily in agricultural research across the region. In the Madagascar context, this would include the potential expansion and capacity building of FOHIFA and related research activities. This makes the World Bank a pivotal partner in the establishment of national research priorities, including those that include the continued development and strengthening of the sorghum value chain.

World Food Programme (WFP)
The World Food Programme’s (WFP) role in the sorghum value chain is one that is primarily a function of demand. The WFP maintains the mission of helping to create markets for smallholder farmers while also working to meet Madagascar’s nutritional and food security needs. However, they have noted that Madagascar’s current sorghum production is not sufficient for WFP’s needs, and as a result have had to import a large quantity of the sorghum they distribute. Moreover, the WFP’s budgetary cycle and funding uncertainty makes mechanisms such as direct contracting mostly inaccessible. WFP’s procurement practices tend to be highly reactionary as a result. It is also important to consider the potential impacts that WFP’s procurement and pricing in any given year may have on the sorghum market and value. Those impacts – whether negative or positive – will directly affect both sorghum farmers and sorghum end users, such as animal feed manufacturers.

Current challenges
Based on multiple conversations, the government of Madagascar is perceived as having limited capacity to help drive agricultural sector growth. However, while the government has been divesting in agricultural research in recent years, representatives are supportive overall when discussing the possibility of expanding sorghum production in the country.
The general infrastructure within Madagascar is a major obstacle to successfully developing livestock and grain production. Aside from transportation infrastructure, the country lacks a strong public agricultural research service that could assist with breeding and testing modern grain varieties as well as educating growers.

While FOFIFA acknowledges the potential for sorghum production in some remote regions, little emphasis has been placed on these regions due to political and safety issues, especially in the South. FOFIFA also notes the lack of infrastructure as a current barrier to sorghum production. Institutions like FOFIFA have inadequate funding, which is a limiting factor for their overall impact.

The formation of strategic partnerships that comprehensively address all points of the sorghum value chain require intentional, engaged leadership with a clear vision of the goals and objectives of each partnership within the broader development of Madagascar’s sorghum value chain. It is currently unclear what organization or actor is positioned to successfully take on that overarching leadership role.

Questions for further assessment

- How can the relationship between the government and the private sector be improved?
- How can producers have better access to and support for adopting new varieties and production practices?
- Are there any other influential companies or organizations missing in this analysis?
- In addition to CTAS, other NGOs are working in the South by assisting growers with inputs and technical support. Could these NGOs be potential collaborators in the seed supply and in education efforts to increase sorghum production?
- Information about grain and feed production is inconsistent among groups and institutions, making it difficult to have specific data. Is it possible to create shared database of resources giving actors access to accurate information?

Key opportunities identified for sorghum value chain strategic partnerships

- The private sector seems very committed to social investment and helping household producers to succeed (e.g., offering technical support, equipment loans, seeds, etc.) – continued support of these models has the potential to help drive long-term improvements and development of the agricultural sector as a whole.
- While on a minor scale, Basan Group, NutriFoods (INVISO Group), and the World Food Programme could be key players in the future. In the case of the Basan Group and NutriFoods, their impact will depend on their interest in including sorghum in current product formulations and developing new products that include sorghum. The World Food Programme’s impact will be highly dependent on the quantities acquired and price floor set.
- Any efforts from the World Bank and other major donor organizations for investment in infrastructure will be critical for the development of a sorghum value chain and helping farmers overcome existing barriers.
Conclusions

Sorghum has a long history in Madagascar, and while its presence in the country has decreased over recent decades, there are numerous areas that would benefit from a resurgence of sorghum production and use. Strategic, targeted interventions in the sorghum value chain could help Madagascar address several major challenges, including drought, accelerated population growth, low levels of food security, and immense need for income generation.

Some key action points that have been identified across the value chain as priority areas of opportunity include:

- A consistent source of quality seed is imperative for any production system anywhere in the world. Efforts should be made to improve the current systems or introduce an alternative. Working with the commercial farms to provide seed to the subsistence farms should be explored further.

- Cross-learning events with the Sorghum and Millet Innovation Lab partners from West Africa should be maximized to identify new varieties, production techniques and value-added food products to accelerate progress toward a higher-functioning system. Pearl millet might be considered as an alternative in the harshest agroecologies.

- Existing commercial farms in Madagascar can lead efforts in training and technical support for improved production techniques as well as in opening value-added market opportunities.

- Education and access to modern farming techniques can assist subsistence farmers - especially mechanization, inputs, and storage equipment. It may be possible for farmer cooperatives or other organizations to pool their resources for needed inputs and equipment.

- There are two well adapted varieties of sorghum currently grown with regularity in Madagascar, but there is great need for a more highly developed system where other varieties are tested and brought to market, both for commercial-scale and subsistence-level use.

- There is a strong need for the development of a sorghum-focused research center within Madagascar with a primary purpose of testing new sorghum varieties as well as housing an improved gene and seed bank and facilitating varietal testing with farmers and cooperatives.

- For sorghum to be adopted as a livestock feed ingredient, a constant supply of grain and a competitive price are crucial. Continued expansion of feed mill on-site storage, improved commercial production techniques, and direct contracting opportunities to help secure grain at an anticipated price can help livestock feed companies keep their production costs more predictable.

- Sorghum transport and supply chain routes are essential for a successful sorghum value chain, but poor transportation infrastructure in Madagascar is a major obstacle that could be addressed by establishing a network of smaller feed mills in strategic areas. This will provide more immediate opportunity for local economic activity and feed availability.

- Opportunities exist to support direct contracts between producers (or farmer cooperatives) and animal feed millers, but these relationships are nascent, and trust-building is crucial.

- Increased interest by larger food companies in integrating sorghum into new product formulations presents the exciting potential for new niche and high value markets for commercial sorghum producers.

- If a more comprehensive, sustainable development of the sorghum value chain is considered a priority moving forward, engaging major actors at all levels of the value chain will be a necessary next step. Fully understanding the interactions between these actors and the strategic partnerships among them will be key to ensuring effective engagement at all levels.

- Securing access to water and common soil amendments (to raise soil pH levels) will go far to create quick positive outcomes for sorghum producers, both at the commercial- and subsistence-level.
The formation of a strategy that comprehensively addresses all points of the sorghum value chain will require intentional, engaged leadership. That leadership must approach the sorghum value chain development with a clear vision of the sector's primary goals and needs and create opportunity across multiple points of the chain if true impact is to be seen.

The only path to realizing the true potential of the sorghum value chain is to simultaneously catalyze market demand with market supply while removing barriers to production, enterprise, and exchange.

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**Associate award prospects**

The Phase I scoping report has listed several interventions and work areas that can be developed into activities to support both short- and midterm development goals. Depending upon the mission’s interest in each area, a comprehensive project proposal and budget can be developed.

It is possible to visualize a set of activities that focus on farm- and community-level interventions, human and institutional capacity development, and the identification of agricultural-, food-, and feed-processing interventions. This would be similar to activities that conducted in Niger over the past 10 years by the Sorghum and Millet Innovation Lab in close partnership with a wide range of actors. SMIL would leverage extensive experience and national French-speaking networks in West Africa, particularly in Niger. These networks include farmer associations, women-led SME food processors, seed system actors (public-, private-, and community-based), Niger’s national agricultural research system, universities, and other stakeholders along the sorghum and pearl millet value chains.

Based upon actual implementation and experience in Niger, we anticipate that an award to conduct a comprehensive set of activities in Madagascar would total US$3.5 – US$4.5 million over a four-year period.