

Using network theory to promote adoption of new agricultural technologies in Sierra Leone



In brief

- The Ministry of Agriculture and Forestry (MAF) in Sierra Leone has identified livestock production as the second most important activity in their 5-year strategic plan and recognizes the central importance of maize as a feed crop for livestock.
- This policy brief suggests that to reap the desired benefits from any policy intervention, a value chain approach to development should be adopted. Such a value chain must involve the development of human capital at the smallholder farmer level, support in the provision of agricultural technology and coordination between the main market actors, namely: farmers, millers and animal feed or poultry producers.
- A feasibility study was carried out jointly by IGC, Y-RISE and WARC, aimed to inform a larger, scaled-up randomised control trial (RCT) to rigorously estimate the impact of this proposed bundled intervention across hundreds of rural villages throughout Sierra Leone.
- Research and interviews with stakeholders have identified three major barriers to the development of a sustainable, domestic animal feed industry within Sierra Leone: information gaps, lack of access to transformative technology, and lack of coordination to effectively gather market information and communicate with potential purchasers in the market.
- This brief also provides context on the potential for adoption of maize in Sierra Leone when given technology to transform maize, access to agro-industry, and access to higher-value market.

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Introduction

In Sierra Leone the Ministry of Agriculture and Forestry (MAF) has identified livestock production as the second most important activity in their 5-year strategic plan (NAT 2023) and recognizes the central importance of maize as a feed crop for livestock. Despite MAF's insistence on the importance of maize in enhancing productivity and competitiveness in the agricultural sector, farmers in Sierra Leone do not grow maize for commercial use. The negative impact of Sierra Leone's missing maize market, and the economic payoffs to developing this market, can be seen in the country's import reliance for poultry; Sierra Leone imported poultry and eggs totalling \$20,537,000 in 2017, 1.605% of total imports (Observatory of Economic Complexity). A recent report on the prospects of poultry farming in Sierra Leone argues that strong demand for maize for animal feed exists, but that local production has not risen to meet this demand (SOBA Poultry Farmers Baseline Report, 2016).

Maize has the potential to grow in all regions of Sierra Leone. Strikingly, survey data from a full census conducted by our research team in 42,090 households across 79 large towns in the lower half of Sierra Leone reveals that 40.3% of farming households and 28% of all households report growing maize. Importantly, as noted by a team of agronomists from our partner organization WARC, maize does not compete against Sierra Leone's primary staple crop, and maize can be grown productively in the same farming plot as rice, just at different seasons of the year (See Annex 1). However, qualitative reports during the data collection note that most households grow maize in small quantities – often in backyard gardens rather than farms – then roast maize street side grills and sell it for local consumption.

Given the strong government support for maize production, the high demand from a nascent poultry industry, and the large potential economic gains for farmers, why is maize not being produced commercially by farmers as a cash crop?

A significant opportunity exists within the poultry value chain in Sierra Leone that is currently hamstrung by the lack of domestic corn meal, a secondary product that can be manufactured through the milling of maize. Poultry is largely imported in Sierra Leone because the animal feed required to produce poultry domestically is not available in adequate supply. It is estimated that:

- If Sierra Leone increased egg consumption to regional levels of 38 eggs per capita per year, this would generate an estimate demand of 285 million eggs, requiring 24,000T of maize to produce; and
- If Sierra Leone increased chicken meat consumption to regional levels of 6.7kg per capita per year, this would generate an estimate demand of 50,000T of meat, requiring 60,000T of maize to produce.

Poultry and maize can be successfully and sustainably produced in Sierra Leone given prevailing agronomic conditions. Furthermore, government

policy currently supports the overarching aim of domestic production of poultry and maize. However, despite these two facts, large import bills for both poultry and maize remain the status quo.

In order to reap the desired benefits from the any policy intervention, it is posited that a value chain approach to development should be adopted. Such a value chain must involve the development of human capital at the smallholder farmer level, support in the provision of agricultural technology and coordination between the main market actors, namely: farmers, millers and animal feed / poultry producers.

Value chain opportunity for welfare catalysation through electricity

The research surrounding agricultural extension as a means of providing the desired outcomes, highlights that the actual impact on performance of farmers and even on a wider dimension of welfare, remains varied and nuanced (Dercon et al, 2009; Gautam, 2000; Danso-Abbeam et al, 2018). The context specificity of agricultural extension programs along with the nuances associated with their type, methodology, and delivery pose a challenge in objectively delivering consistent welfare benefits. Agricultural extension programs by themselves face major challenges in providing consistent welfare benefits in rural communities.

The World Bank in its 2019 report, 'Harvesting Prosperity' notes, "The available evidence suggests farm productivity rises and the prices received for outputs are higher as a result of being part of a value chain. In addition, there are spill over benefits to members beyond the chain in the form of a demonstration effect by incentivizing similar contracting mechanisms in other crops and value chains." (World Bank, 2019) Although most evidence on strong productivity effects are from high- and medium value products, recent studies provide evidence of the farm-level effects of contract schemes in staple crops in poor countries. (Ragasa, Lambrecht, and Kufoalor, 2018 & Maertens and Vande Velde, 2017).

Put together, the available evidence tends to suggest that well thought out market access interventions have the ability to drive increases in production efficiency, with evidence supporting the hypothesis that this may be driven through 'learning by doing' (Atkin et al, 2017; Bernard et al, 2017; Casaburi, 2014).

Developing these value chains faces challenges however, including: information challenges, coordination issues and risks of elite capture. Information challenges exist with respect to a lack of knowledge and sensitization to new forms of agricultural business particularly within highly impoverished rural communities. Coordination issues exist both on the supply and demand side of the market. Once a product has been manufactured, should the market players on both sides be fragments and unconsolidated, coordination mechanisms need to be put in place to ensure

frictionless flows of information and efficient transactions. Finally, where enabling technology is being used to catalyse agricultural transformation, there is a risk of elite capture of the technology and its productive use, particularly where property rights are loosely enforced.

Sierra Leone poultry market opportunity

We observe that in Sierra Leone food imports comprised of 28.5% of all merchandise imports in Sierra Leone (UN Comtrade, 2016). Relatedly, poultry imports made up 34% of all animal products imported into Sierra Leone in 2017 - the largest in this category by a significant margin. If egg imports (a poultry by-product) are included, then this number increases to 49% of all animal product imports (UN Comtrade, 2016). This has implications for food security within Sierra Leone, as poultry (along with fish) constitutes the country's most important source of protein. It has been assumed in the past that countries like Sierra Leone had to import food because they were lacking infrastructures needed to develop an industry (e.g., roads and electricity). Yet, recent studies have explored how access to higher valued markets can incentivize farmers to adopt more productive crops and change investments in inputs to increase the quality of their goods (Atkin et al., 2017; Ashraf et al., 2009; Bernard et al., 2017).

Poultry is largely imported in Sierra Leone because the animal feed required to produce poultry domestically is not available in adequate supply. Interviews with poultry farmers and animal feed producers indicate that the key bottleneck preventing the production of feed domestically is the lack of reliable quantities of maize which, when transformed into corn meal, is the main component of poultry animal feed. Not only is the majority of the poultry animal feed by weight, but this component takes up the vast majority of costs associated with the manufacture of animal feed.

Due to this vulnerability in the food system, the Ministry of Agriculture and Forestry (MAF) has identified livestock production as the second most important activity in their 5-year strategic plan (NAT 2023) and recognizes the central importance of maize as a feed crop for livestock. Despite MAF's insistence on the importance of maize in enhancing productivity and competitiveness in the agricultural sector, farmers in Sierra Leone do not grow maize for commercial use. The negative impact of Sierra Leone's missing maize market, and the economic payoffs to developing this market, can be seen in the country's import reliance for poultry; Sierra Leone imported poultry and eggs totalling \$20,537,000 in 2017, 1.605% of total imports (Observatory of Economic Complexity). A recent report on the prospects of poultry farming in Sierra Leone argues that strong demand for maize for animal feed exists, but that local production has not risen to meet this demand (SOBA Poultry Farmers Baseline Report, 2016).

Maize has the potential to grow in all regions of Sierra Leone. Strikingly, survey data from a full census conducted by our research team in 42,090 households, across 79 large towns in the lower half of Sierra Leone, reveals

that 40.3% of farming households and 28% of all household's report growing maize. Importantly, as noted by a team of agronomists from WARC, maize does not compete against Sierra Leone's primary staple crop, and maize can be grown productively in the same farming plot as rice, just at different seasons of the year.

Feasibility study

A feasibility study was carried out jointly by IGC, Y-RISE and WARC, and aimed to inform a larger, scaled-up randomized control trial (RCT) that will rigorously estimate the impact of this proposed bundled intervention across hundreds of rural villages throughout Sierra Leone. Three main activities were carried out to verify the suitability of the proposed bundled intervention to the local Sierra Leonean context, as well as ensure its overall feasibility.

1. A Smallholder Farmer Survey was conducted.
2. Semi-structured interviews with Key Value Chain Actors were performed.
3. The prototype of the electrified maize processing machine (a maize dryer) was fabricated and installed in two rural villages.

Key findings from this study were:

- First, the Smallholder Farmer Survey had three main findings: (i) the lack of farming machinery is a top challenge faced by smallholders, (ii) maize is a cash crop in Sierra Leone (unlike rice, which is a subsistence crop), and (iii) access to rural electricity and post-harvest processing technology is severely restricted among the surveyed smallholders (hindering their ability to produce higher value-added maize products).
- Second, the semi-structured interviews with Key Value Chain Actors uncovered four main constraints smallholder maize farmers face: (i) the unavailability of key inputs, (ii) limited market access, (iii) a lack of adequate storage, and (iv) a lack of credit.
- Third, the fabrication and installation of the maize dryer machine in two rural villages was necessary for three reasons: (i) to ensure the prototype designed by Stanford engineers was indeed functional in rural Sierra Leone, (ii) to uncover administrative procedures (some formal, and some informal) that must be followed during the scale-up, and (iii) to iterate and finalize the design as well as create a step-by-step installation guide for future installations.

On the whole, this feasibility study largely validated the concept of a value chain approach to catalysing welfare improvements through the proposed bundled interventions. With the constraints around rural electrification, electrified farming technology, extension services, and market access relaxed (if not resolved), smallholders will be much better placed to move from subsistence towards commercialization. It was determined that this transition is a necessary precondition for broader agricultural transformation.

Summary of proposed value chain

Given the strong government support for maize production, the high demand from a nascent poultry industry, and the large potential economic gains for farmers, why is maize not being produced commercially by farmers as a cash crop?

Research and interviews with stakeholders in Sierra Leone have identified three major barriers to the development of a sustainable, domestic animal feed industry within Sierra Leone:

1. **Information Gaps:** farmers in rural communities of Sierra Leone are not sensitized to the concept of maize farming and have not been appropriately trained. Furthermore, most of these farmers are subsistence farmers, and as such the investment of time and capital into a crop not for consumption requires a certain level of risk taking.
2. **Lack of Access to Transformative Technology:** maize milling and drying are both labour and capital intensive if conducted without the use of mechanized technology thus making it both quality and cost inefficient compared to imported alternatives.
3. **Coordination Challenges:** there is a lack of coordination between smallholder farmers to effectively gather market information and communicate with potential purchasers in the market.

Through electricity enabled interventions and thoughtful design, a value chain can be developed to allow for sustainable, domestic animal feed production that will not only help foster the domestic poultry industry but also have flow on benefits to the rest of the economy. The components of such an intervention are:

1. **Agricultural Extension:** provision of a bundle of services to help inform and train farmers on best practices for maize farming.
2. **Agricultural Processing Facilities:** installation of electric maize dryers and mills at the community level that leverage the DFID solar mini grids. This technology will allow for efficient production of high-quality corn meal that can form the basis for poultry animal feed.
3. **Market Access:** coordination between local poultry farmers and corn meal producers through guaranteed purchase agreements.

The research project intends to provide context on the potential for adoption of maize in Sierra Leone when given technology to transform maize, access to agro-industry, and access to higher-value market. Such mechanized processes are currently missing in Sierra Leone because of low connectivity to reliable electrical infrastructure. By leveraging a recently implemented rural electrification program, we evaluate the effect of introducing into large rural towns privately managed electrified agricultural processing appliances (e.g. maize dryers and mills) on farmers' maize production patterns.

A coordinated, thoughtful value chain design which leverages the electricity inputs has the ability to drive positive outcomes for all stakeholders as outlined below.

- **Smallholder maize farmers may experience financial and health benefits.** From a financial outcome standpoint, the value chain may increase their income by connecting them to poultry farmers who are willing to pay a premium for quality maize. Increased income may lead to consumption and savings smoothing which will transition the farmer away from sustenance farming and decrease the likelihood that they stay trapped in the cycle of poverty. Additionally, this increase in income could allow the farmer to start saving their money in preparation for a bad harvest or to invest in additional capital. In addition to the financial benefits, the smallholder maize farmer and their family could experience health benefits through increased food security and diversity which can generate greater variety in the nutritional elements that the farmers are able to obtain from their food.
- **Poultry farmers may reap financial benefits from participating in the value chain because they are currently importing most of the maize that goes into animal feed which is expensive and unreliable.** Through contracting with local smallholder maize farmers or aggregating maize millers, the poultry farmers shall be able to ensure a higher quality and consistency of the product while likely also paying a price that is less than what it currently costs to import the good. They may also be able to scale their operations as their source of maize becomes more dependable.
- **Local communities could be greatly impacted by the creation of this value chain because they could experience significant spill over benefits.** From an environmental standpoint, the land that is being used to grow the maize should have healthier soil because the rotating maize and rice growing seasons will introduce nutrients back into the soil on a regular basis. This will reduce the need for harmful fertilizers to be introduced into the soil and also promote sustainable agricultural practices. From a financial standpoint, the smallholder maize farmers will have more income to buy other products. As we see in the value chain literature, the preferences of these farmers will shift as their incomes increase as a result of the value chain which will have spill over effects on the community with which they interact. The introduction of secondary industry within rural communities in Sierra Leone could have significant multiplier benefits driven by a move into the formal economy.
- **Egg and poultry consumers should see an increase in the quantity and quality of their products that they are buying as well as a decrease in the price that they have to pay for these products.** There is currently an insufficient supply of local eggs and poultry to meet the local level of demand, so a lot of what is currently available in supermarkets and general markets is imported. This importation decreases the shelf life of the product and also increases the price. Through the creation of the value chain, the poultry farmers will have a more dependable source of maize which is a critical input into their animal feed and they will

be able to increase the quantity of eggs and poultry that they supply to the market. The products will therefore likely be cheaper than what is currently being imported and healthier since supply chain is shorter and more transparent.

- **The Sierra Leone economy may also benefit as the value chain catalysation could stimulate employment in the rural communities and introduce diversification to the economy.** The value chain will also formalize a supply chain in the animal feed market which will have logistical and coordination benefits for other industries in the region.

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