Value chains for beans and maize in Honduras: opportunities for innovations at scale

CGIAR INITIATIVE ON Rethinking Food Markets

Scoping Study Report

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ACRONYMS

AI	Artificial Intelligence
Alliance	Short for "Alliance Bioversity International and CIAT"
CGIAR	Consultative Group on International Agricultural Research
CIALs	Local Agricultural Research Committees, by its Spanish acronym
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
COSUDE	Swiss Agency for International Development and Cooperation, by its Spanish acronym
DEMAHSA	*Derivados del Maíz de Honduras S.A.*
DICTA	*Dirección de Ciencia y Tecnología Agropecuaria*
DR-CAFTA	Dominican Republic-Central American Free Trade Agreement
ECAs	Farmer Field Schools, by its Spanish acronym
FUNDER	*Fundación para el Desarrollo Empresarial Rural*
IHMA	*Instituto Hondureño de Mercadeo Agrícola*
MSME	Micro, small and medium enterprises
NGO	Non-Governmental Organization
PyENSAN 2023	*Política y Estrategia Nacional de Seguridad Alimentaria y Nutricional con horizonte al 2030*
SIMPAH	Market Information System for Agricultural Products of Honduras, by its Spanish acronym
SME	Small and medium enterprises
UNAH	*Universidad Nacional Autónoma de Honduras*
USDA	United States Department of Agriculture
WFP	World Food Program
WP	Work Package
Zamorano	Pan-American School of Agriculture, a private university

Introduction

The Rethinking Food Markets and Value Chains for Inclusion and Sustainability Initiative (Rethinking Markets for short) aims to provide evidence on what types of bundled innovations, incentive structures, and policies are most effective at creating more equitable sharing of income and employment opportunities in growing food markets, while reducing the food sector's environmental footprint. The Initiative seeks to discover promising and adaptable innovations for improved vertical coordination, inclusive contracting, certification for food quality and sustainability, inclusive digital platforms, and more. It plans to achieve this by focusing its work on four working groups (Work Packages-WP). WP1 and WP2 focus on markets for high-value food commodities; one on globally integrated value chains catering to international markets (WP1) and the other on food value chains serving domestic markets (WP2). WP3 focuses on inclusive business models for using digital technologies in cross-food-market services, especially in logistics and finance, and WP4 collects inputs and lessons from the first three WP and creates a knowledge platform to facilitate policy dialogue and exchange of evidence and ideas, as well as a global agrifood database that can be used for global and country scenario analyses to assess the potential for and tradeoffs associated with scaling (Vos and Wiegel 2021).

WP2's work concentrates on identifying opportunities to improve participation and profit of smallholder farmers and agrifood small and medium enterprises (SMEs), and lowering their environmental footprint by identifying, adapting, and scaling interventions in three areas: (i) innovations to improve logistics and create inclusive business models and value chain contracts; (ii) product quality upgrading and food standard certification, and (iii) an enabling policy environment for sustainable development of domestic food value chains (Vos and Wiegel 2021). Further, this working group aims to evaluate the effectiveness and synergies between innovations in the domestic chain of common beans and maize, in Honduras, contributing to eliminating the barriers that small producers (including women and young people) face to participate in and benefit from them. To meet its objectives, this group has organized its activities into three stages. During the first stage, interest focuses on knowing the current situation of the value chains in the country, identifying challenges and opportunities to innovate across the different links. In the second stage, a pilot study will be designed and implemented to evaluate innovations identified during the first stage, and that have potential for impact. Finally, in the third stage, scaling strategies will be defined to promote the use of the innovations evaluated and that showed a positive impact.

During the first stage, the initiative did an event with key actors in June 2022 in Tegucigalpa, Honduras, to inaugurate the initiative (along with other initiatives promoted by the Consultative Group on International Agricultural Research-CGIAR). During this event, participants gave their opinions about the most relevant topics for beans and maize in the country, information that served to guide the initial work of the initiative. Then, we designed and implemented a scoping study to identify challenges and innovation opportunities to make bean and maize value chains more inclusive and profitable. This document presents the results of this study, which is a first step to identify innovations that could be evaluated in a future pilot study, together with local partners.

The rest of this document is structured as follows. The next section presents background information about the value chains of interest. Then we present the objectives of the scoping study and methods used. We later present results, organized following the research streams (which we identify as research components) described in the conceptual framework, and identifying potential innovations for evaluation in a pilot study. The references and annexes are presented in the last two sections.

Background

The bean subsector

Beans (Phaseolus vulgaris L.) are one of the most important legumes in the daily diet of the Honduran people, ranking second only to maize in terms of area planted, production and consumption (SAG-DICTA, 2012; Escoto, 2015; FAOSTAT, 2023). Although red and black beans are produced, the production of black beans is small and concentrated in the western region, near the border with El Salvador (Escoto, 2013) and Guatemala, and few other small areas (in the department of Comayagua). Among red varieties, light red beans are the preferred market class (Lardizábal, Arias and Segura, 2013).

The bean value chain starts with the producers on one side and ends with the consumers on the other side. The main value chain nodes include actors who produce beans (the production node); actors who trade beans (the marketing node); actors who process beans (industry node); and actors who consume beans (consumption node). In the production node we find independent and organized producers. In the marketing node we find farmer associations, intermediaries (commonly called "*coyotes*"), institutional buyers (the Instituto Hondureño de Mercadeo Agrícola-IHMA, and the World Food Program-WFP), wholesalers (in main markets, exporters), and retailers (supermarkets, small shops). In the industry we find food processing firms who process, package, and sell beans. Finally, among the consumers we find households, food service providers, and groups of individuals benefiting from institutional programs (like the government's school meal program). These value chain actors work under a legal framework that contains the various laws, policies and/or strategies of the country; and receive services that support the chain operations, such as finance, transportation, technical support, research, and input suppliers.

Some actors interviewed for this study mentioned that, given the importance of this grain for food security and the number of domestic producers, the variety of companies, institutions and development agencies in the sector is small. This results in producers lacking technical assistance, training, financing, and other essential services to keep the value chain running optimally. Further, they mentioned that, although in some producing regions the use of improved seeds and technical assistance has helped improve yields, this do not always translate into better incomes for producers due to high production and labor costs, and low selling price. On the marketing side, these actors mentioned that technical assistance, the use of improved seeds and better post-harvest management have contributed to improve the quality of the beans sold; however, when demand is not met by local production, imports (mostly from Nicaragua) are common.

The organizational aspect at the value chain level has improved thanks to the establishment of regional committees, national chain committees and a Bean Chamber. This process began in 2018, with the support of various institutions (the national agricultural research center-DICTA; a private marketing service provider-Agrobolsa; a non-government organization-TechnoServe; and a private institution-FUNDER) within the scope of the Sustainable Agriculture Improvement (MAS) project. This model gives organized small producers better access to new markets where they could receive better prices (like IHMA, for example). Interviewed actors recognized that this is the only formal bean marketing channel with a guaranteed price accessible to small bean producers in the country.

According to the farm size, there are three types of bean producers: small producers (approximately 90% of all producers) who cultivate 0.35 to 3.5 hectares (ha); medium-sized producers (approximately 8% of all producers) who cultivate 3.5-7.0 ha; and large producers who cultivate over 7.0 ha (SAG, 2011). This author states that the consensus is that small farmers produce the largest share of beans. Most small producers use recycled grain from previous harvests as planting material, with limited use of certified seeds (of improved varieties). The latter is due to its low availability, high cost and preference for light red grains (a characteristic common of traditional varieties) because of its greater market acceptance. Mather et al. (2003) demonstrated that dark red beans (a characteristic common of older improved varieties) face price discounts by buyers, compared to light red beans. However, newer improved varieties are light red, and although are still slightly darker than traditional varieties, this characteristic is expected to increase their acceptance among potential users. In contrast, large scale producers generally use more modern technology, have access to better markets (and market conditions), have more information about markets and prices, and invest more resources (land, labor, capital) on their crop.

SAG-DICTA (2019) recommends the use of the following improved red varieties, available to farmers: Amadeus 77 (the most adopted variety in the country [Reyes et al., 2016]), Deorho, Paraisito Mejorado 2, Honduras Nutritivo, Tolupán Rojo and Rojo Chortí.[1] In Honduras, the major sources of certified bean seeds are DICTA, Zamorano, and the Red Pash.

Bean are grown in 16 of Honduras' 18 departments, from sea level to 1,800 meters above sea level (m.a.s.l.) The country is divided into seven regions where beans are produced, and more than one-half of national production is produced in two regions (Table 1). Although these statistics are outdated, the relative importance of these regions does not appear to have changed, at least not for the main producing regions.

Table 1. Share of bean production, by region and department

Region	Department	Production (% of total)
Centro oriental	El Paraíso y Francisco Morazán	30
Nor oriental	Olancho	22
Norte	Cortés, Yoro y Santa Bárbara	18
Centro occidental	Comayagua, Intibucá y La Paz	14
Occidental	Copán, Ocotepeque, Lempira	11
Sur	Choluteca y Valle	4
Litoral Atlántico	Atlántida, Yoro, Colón	1

Source: Escoto (2015)

The bean crop could be produced year-round with irrigation. However, there are two main seasons for this crop (both rainfed): the Primera, that starts in May and ends in August; and the Postrera, that starts in September and ends in December (SAG-DICTA, 2019). The most recent INE data[2] shows, for the last 3 years of available data (seasons 2016/2017-2018/2019), that 69% of area and 64% of the production is carried out in the Postrera season, which confirms this is the main bean-producing season in the country. Regarding area harvested and production over time, we observe that, between 2018-2022, the bean area in Honduras averaged 162,197 hectares (ha) and production averaged 129,777 tons (MT) of dry grain (Figure 1), with mean yields of 800 kg/ha. During this period, there was slightly higher variability in the production (Coefficient of Variation=0.017) than in area harvested (CV=0.016) or yields (CV=0.003).

During the same period, Honduras has behaved as a net bean importer, importing an average of 16,359 MT of beans, compared to the 2,520 MT exported (Figure 2). In terms of variability, there has been higher variability in the amount exported (CV=0.334) than in imports (CV=0.152) or the trade balance (CV=0.207) (Annex 1). Further, we observe that the amount imported in 2022 was almost 27% higher than the five-year average. Although it is not clear why this could have happened, given that neither production nor yields were lower in 2022 compared to the previous four years, this most likely responded to an increase in local demand which could not be satisfied with national production. Exports' main destinations are the markets of El Salvador and the nostalgic market[3] in the United States of America.

When analyzing production and trade data together, we note that the country's apparent demand for the period averaged a little over 143 thousand metric tons of beans (Table 2). Honduras' self-sufficiency rate, estimated as the share of apparent demand that is satisfied by national production, is just above 90%, meaning that the country's national production is not enough to cover its demand.

[1] They also recommend the black varieties Azabache 40 and Lenca Precoz, for farmers who produce this market class.
[2] https://www.ine.gob.hn/publicaciones/anuarios%20sen/Anuariosen2015-2019/3SectoresEconomicos.html (accessed on September 28, 2013). We do not include further details using these data as this source provides estimated values (instead of actual data) and the latest year of available data was for the 2018/2019 season.
[3] Honduran nationals who demand beans from their own country.

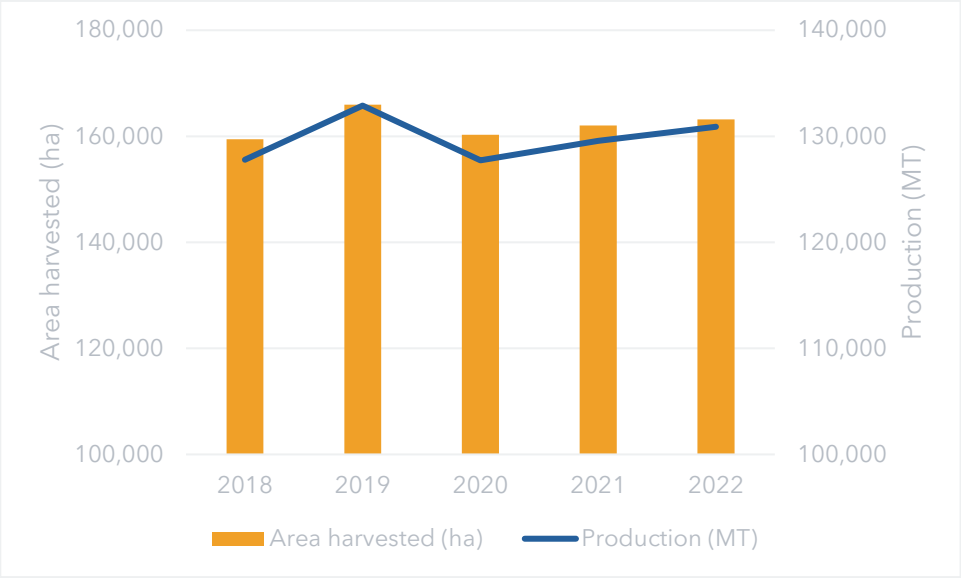


Figure 1. Bean area harvested (ha) and production (MT) in Honduras. 2018-2022
Source: FAOSTAT (2023)

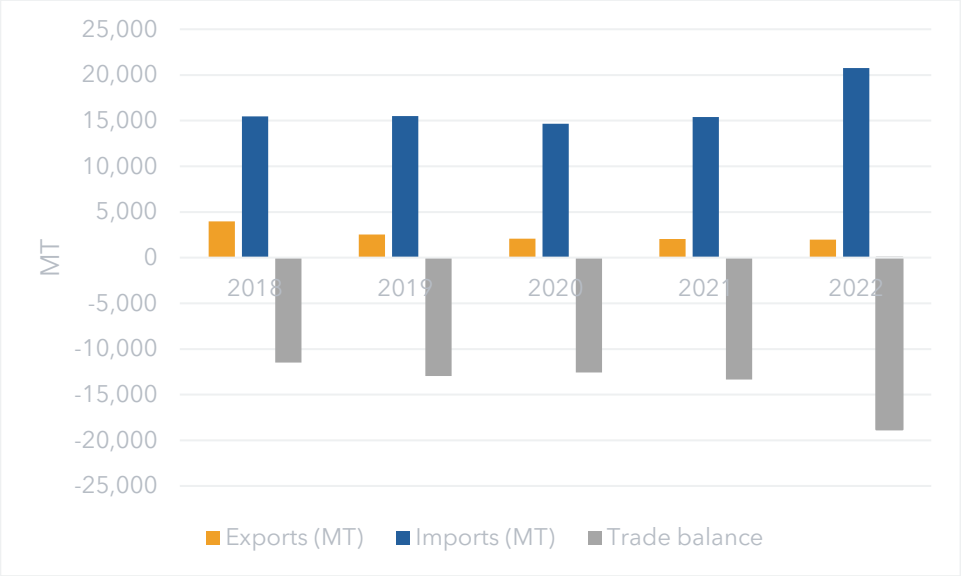


Figure 2. Exports (MT), imports (MT) and trade balance for beans in Honduras. 2018-2022
Source: FAOSTAT (2023)

Table 2. Honduras' apparent bean demand and self-sufficiency rate

Year	Production	Imports	Exports	Apparent demand	Self-sufficiency (%)
2018	127,781	15,467	3,970	139,277	91.7
2019	132,893	15,507	2,538	145,861	91.1
2020	127,733	14,665	2,080	140,318	91.0
2021	129,571	15,384	2,048	142,908	90.7
2022	130,907	20,771	1,962	149,716	87.4
Mean	129,777	16,359	2,520	143,616	90.4

Source: FAOSTAT (2023). Apparent demand (production + imports - exports) and self-sufficiency (production/apparent demand) estimated by the authors.

In terms of gender aspects and inclusion, the bean chain is dominated by men. Women are partially involved in harvesting, post-harvesting (drying and grain selection), and marketing activities; and how they are integrated into these activities depends on the region where they live, marital status, education, and time availability. Moreno et al. (2013a) found that only 4% of households surveyed for a study about farmers' knowledge of two improved bean varieties were headed by women, and Acosta et al. (2019) state that although women have less access to credit for agricultural activities, play a fundamental role in determining how much grain is left for household consumption. However, research has shown that households where women have access to credit or have control over income have diverse diets, and those with women's access to credit are also less likely to experience moderate to severe food insecurity (Larson, Castellanos, and Jensen, 2019). Further, women who belong to organized groups are usually more involved in productive activities, and in leadership and decision-making positions within the organizations. For example, women currently (2023) lead few sectoral committees of the bean value chain, and the Bean Chamber in Honduras. This is probably due to governments and local development and cooperation agencies promoting gender equality initiatives in productive and organizational processes. Participatory agricultural platforms, such as local agricultural research committees (CIALs), have the potential to open spaces for challenging gender inequalities and providing support for women empowerment (Humphries et al., 2012).

Regarding inclusion, it is important to discuss two aspects affecting the sector. First, migration from the region to North America, which has increased recently, from nearly 600,000 in five years, to 3.4 million in 2015, and approximately four million in 2020 (IOM and WFP, 2022). Although it is a complex problem, these authors mention that some of the main factors influencing this phenomenon are food insecurity, few income opportunities, lack of safety and security, the impacts of natural hazards, among others. They further point that the usual profile of the immigrants are young males of working age, and that more females migrate from Honduras than from El Salvador or Guatemala. This creates a problem due to, among other things, labor shortages for key activities, which increases labor cost and reduces profits.

Second, digital inclusion. Honduras has an information and communications technology (ICT) development index (IDI) of 3.3, which is below the regional average, ranking 32/35 in the region and 129/176 globally. Internet access is mainly through mobile broadband networks with an 78.4% average of the population within the range of a 3G mobile cellular signal in 2018 (Cruz et al., 2021). These authors found that 95.1% of people owned a mobile phone in rural areas, and although owning smartphones was not common, the use of WhatsApp among the ones who did was common. Despite this, they point out that the most relevant challenges for digital inclusion in rural areas of the country include the low development of information systems aimed at small producers, the low level of digital literacy, and connectivity. Further, they highlight the role of rural youth in the promotion of digital technologies, as they are key actors in linking the adult population with new digital tools. The latter is a challenge, given the existing migration problems already explained.

The maize subsector

Maize is one of the most important staple foods, along with beans. It accounts for 26% of calories consumed in major cities and 48% in rural areas. According to the available information from the year 2010, the per capita consumption is 74.0 kg per year (DICTA, 2017). Most of this grain is consumed in the form of tortillas made using the traditional nixtamalization process or using maize flour.

This cereal occupies first place in a harvested area with 360,910 ha and an average production of 663,689 MT of dry grain (Figure 3), with average yields slightly higher than 1,800 kg/ha. During the 2018-2022 period, there was slightly greater variability in production (Variation Coefficient=0.067) than in the harvested area (CV=0.066) or yields (CV=0.011). The three parameters are almost four times more variable in maize than in beans. maize production has a very pronounced seasonality. The maize harvest could occur in any of two seasons (both seasonal): First or Second. The most recent data from the INE show, for the last 3 years of available data (2016/2017-2018/2019 seasons), that 80% of the surface and 88% of production is carried out in the Primera season, which confirms that this is the main maize-producing season in the country. This is because irrigation is needed to produce in Postrera since the crop cycle extends further when the rains end.

The domestic maize production market is characterized by a high degree of informality, with intermediaries playing a very important role in the purchase of maize directly from producers in the production areas and its subsequent transportation and sale in various wholesale markets in the country. Another important market for maize production is through purchase and sale agreements between organized producers and the processing industry, which have the support of the government through the SAG (COHEP, 2021).

The domestic demand for maize in Honduras is around 1.5 million tons per year. This means that the country is forced to import much of its maize. This is mainly yellow maize for animal feed and white maize to meet the needs of the flour industry. During

the 2018-2022 period, Honduras has behaved as a net maize importer, importing an average of over 776 thousand MT, compared to the 1,945 MT exported (Figure 4). In terms of variability, like beans, there has been higher variability in the amount exported (CV=0.796) than in imports (CV=0.203) or the trade balance (CV=0.202). Although there is higher variability in maize in both the amount exported and imported, compared to beans, the variability in the trade balance has been almost the same for both crops (Annex 1). Like beans, we observe that the amount of maize imported in 2022 was higher (34%) than the five-year average, and in contrast to beans, the amount exported in 2021 and 2022 was almost twice the five-year average.

When analyzing production and trade data together, we note that the country's apparent demand for the period averaged a little over 1.4 million MT of maize (Table 3). Honduras' self-sufficiency rate, estimated as the share of apparent demand that is satisfied by national production, is much lower than for beans (at 46.5%), meaning that the country's national production is not enough to cover even one=half of its demand, making it highly dependent on imports.

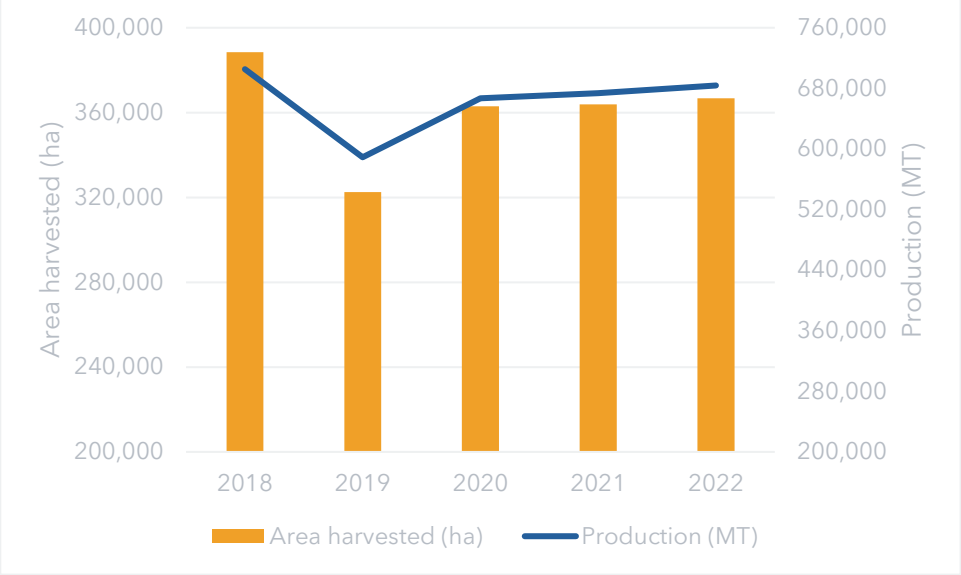


Figure 3. Maize area harvested (ha) and production (MT) in Honduras. 2018-2022
Source: FAOSTAT (2023)

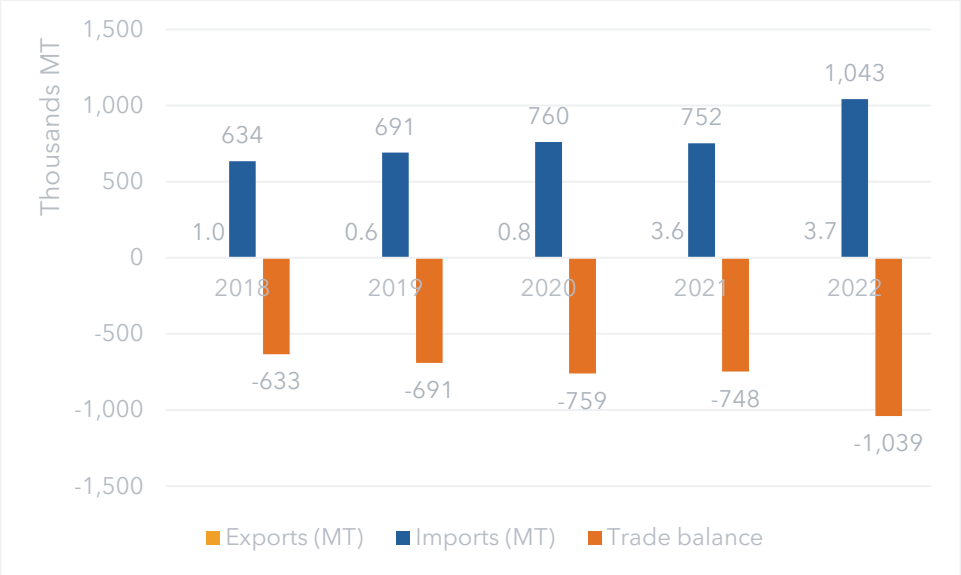


Figure 4. Exports ('000 MT), imports ('000 MT) and trade balance for maize in Honduras. 2018-2022
Source: FAOSTAT (2023)

Table 3. Honduras' apparent maize demand and self-sufficiency rate

Year	Production	Imports	Exports	Apparent demand	Self-sufficiency (%)
2018	705,309	634,440	1,000	1,338,750	52.7
2019	589,020	691,370	624	1,279,766	46.0
2020	666,799	759,899	834	1,425,863	46.8
2021	673,593	751,933	3,591	1,421,935	47.4
2022	683,724	1,042,691	3,679	1,722,736	39.7
Mean	663,689	776,067	1,945	1,437,810	46.5

Source: FAOSTAT (2023). Apparent demand (production + imports - exports) and self-sufficiency (production/apparent demand) estimated by the authors.

As mentioned in the section on the bean subsector, women's participation in productive value chains is limited. This is related to the multiple challenges they face in accessing land, credit, technical training, and participation in production and marketing decisions. Cultural and social barriers also limit their role in family and community decision-making. Moreno et al. (2013b) found that only 2.7% of households surveyed for a study about the dissemination of good practices for the introduction of maize varieties were headed by women. NGOs and government agencies in Honduras have implemented programs to address these gender inequalities by providing training, access to resources, and opportunities for women to participate more fully in the maize value chain and agricultural decision-making. However, these efforts are insufficient and their role in the chain remains invisible.

Honduran maize and bean-based food processing industry

The maize and bean food processing industry in Honduras plays a crucial role in the development of these value chains. It provides employment opportunities and contributes to the overall growth of the agricultural sector. In the country, the maize-based processed food industry is much more developed than the bean-processed food industry. The maize processing sector is made up of four flour companies (DEMAHSA, INDECASA, IMSA, and MATURAVE) and an undetermined number of SMEs that produce maize-based products, such as tortillas, snacks, tamales, cob products, and bread. The maize flour industry is currently dominated by the Mexican multinational GRUMA, through its subsidiary in Honduras, DEMAHSA, which has established itself as a major player in the industry, with a significant market share and supplying most of the maize flour to food processing SMEs and households to produce tortillas. The industrialization of maize in the form of flour has caused a notable reduction in the nixtamalized dough and a rapid growth in the use of flour to process almost all by-products, including tortillas, breads, and snacks.

The bean food processing industry is smaller. This industry has long been overshadowed by other more prominent sectors of the food industry, such as the maize processing industry. This industry is less promising because the Honduran population prefers the consumption of home-cooked beans, resulting in limited demand for commercially prepared beans. However, a small group of SMEs has emerged that has found a way to cater to the convenience-seeking consumer by offering them ready-to-use, cooked, blended, and packaged beans.

In both value chains, SMEs play a crucial role, particularly in the production and marketing of ready-to-eat foods. These SMEs are predominantly family-owned, although there are also some associations and private companies involved in this sector. These SMEs have demonstrated a strong commitment to innovation by developing and transforming their products, processes, and services to meet changing market demands and grow their businesses. In the maize food processing sector, traditionally all products have been made with nixtamalized maize dough. However, the flour industry offers different types for its production, which allows greater use (more details in the results section).

The maize and bean-based food processing sector is not without challenges, particularly for SMEs. Most of them face various challenges to their growth, innovation, and competitiveness. One of the main challenges they face is the lack of adequate processing infrastructure. Many struggle to invest in modern, efficient processing equipment, hampering the productivity and quality of their products. Another important challenge is non-compliance with industrial hygiene and safety programs. Many lack the knowledge and resources to implement and maintain proper hygiene practices in their processing facilities. Limited access to financing services is another major challenge faced by SMEs. Due to their size and limited assets, these companies often have difficulty obtaining loans or investments for expansion or modernization.

Policies and regulations

FAOLEX[4] lists many of the most relevant policies and regulations affecting the sector, and we summarize some in this section. Before getting into details, we want to highlight the role of the Honduran Institute for Agricultural Marketing (IHMA, by its Spanish acronym), an institute established in 1978 with the mandate of securing basic grains (beans and maize included) to maintain the national grain reserves and regulate local prices thru the direct purchase and sale of grains locally and internationally, and guaranteeing their supply to consumers (FAO, 2010a). IHMA purchases grain from farmers at competitive prices; usually thru an open-bid process. Although this could be a market opportunity for farmers, who could receive higher prices, it limits the type of farmers who supply IHMA, because this institution has specific quality standards and volume requirements, which usually only large-sized farmers or farmer groups can satisfy, effectively excluding small individual farmers from the process. Despite this, the local market usually takes the floor price established by IHMA into consideration when setting market prices. The original decree was slightly modified in 1979 (FAO, 2010b), regarding how its Board is constituted, to include representatives from the business and farm associations sectors.

In 1980, the national seed law was published to regulate the work of the National Seed Production Program, with the goal of promoting and regulating seed production, certification, marketing, imports, and exports; while overseen its quality along all stages of production; functioning as a fiscal agent in the marketing of certified and commercial seeds (FAO, 2019a). This law does not appear to have been updated since it was published. Later in this decade (in 1987), a law to promote and protect cooperatives (in production, services, consumption, and any mix of types) was published (FAO, 2018). This law, amended in 2013 and 2017, declared that there was a need, and it is of public interest the promotion and protection of cooperatives, and guaranteeing their free development and autonomy. This paved the way for this sector to be incorporated into the national platforms, including having representatives in state bodies, when appropriate.

In the early 1990s, a law for the agricultural sector's modernization and development was published to put in place all necessary means to modernize the agricultural sector and to allow farmers to produce foods and other goods efficiently, while using resources consciously (FAO, 2019b). Among its many objectives, it included benefiting agricultural investments and job generation; promoting the agroindustry development; and strengthening technology generation and transfer services. This law updated two former laws (from 1974 and 1980), and has been updated since, in 1998, 2005, and 2008 (twice). After this, in 1993, a law for rural savings and credit banks was established to create the rural banks system as a private entity that serves as an intermediary financial institution in rural areas, with the goal of facilitating farmers' access to loans and other financial services (FAO, 2001). Later in this decade, two additional laws of relevance to the sector were set: the law to stimulate production, competitiveness and human development, in 1998 (FAO, 2020a); and a regulation to establish the National Basic Grains Council ("*Consejo Nacional de Granos Básicos*"), in 1999 (FAO, 2007). While the former law's goals were, among others, to incentivize smallholder agricultural and livestock production, thru accessing financing by extending land deeds to be used as collateral, and the development of rural and peri-urban microenterprises; the regulation goal was to approve the establishment, integration and functioning the said national council, as the institution that advice, promotes, consults, and coordinates related activities in the private and public agricultural sector.

In the first decade of the current century, a state policy for the agrifood and rural sector was established in 2004 ("*Política de Estado para el Sector Agroalimentario y el Medio Rural 2004-2021*"), to transform the sector thru improving its competitiveness, contributing to the reduction of rural poverty, and food security (FAO 2023a). This law has not been updated yet. Regarding regulations for enterprises, there is one law with two updates: the law for the promotion and development of the competitiveness of the micro, small and medium sized enterprises, published in 2009 (FAO, 2017a), and updated in 2013 (FAO, 2017b) and 2018 (FAO, 2019d). While the first law was to promote and develop the competitiveness and productivity of these enterprises; the second was to reactivate the sector, through the refinancing of loans, so these enterprises could secure new or expand their existing credits. In contrast, the third law was oriented towards micro and small enterprises only and outlined incentives to foster their economic growth. This law formalized enterprises that were not in the formal sector, through the emission of a special certificate, so they could get benefits (and responsibilities), they coo uld not previously have access to.

The National Seed Council was established by law in 2014, to contribute to the availability, accessibility, and use of quality seed by producers (FAO, 2019c). This law stated that this council was to be constituted by institutions dedicated to research, development, production, conditioning, marketing, and use of seed, and human resource formation, under the coordination of DICTA. In the same year, the Grain Quality Norms for common beans were approved, to specify food safety and grain quality requirements for the marketing of dry beans for its consumption by humans. These norms do not include processed beans.

[4] https://www.fao.org/faolex/country-profiles/general-profile/en/?iso3=HND

Related to food and nutritional security, there is one strategy (which has been updated) and one law. In 2010, the country approved its National Strategy for Food and Nutritional Security 2010-2022, aligned to its long term State Policy for Food and Nutritional Security. The goal of this strategy is to guarantee food and nutritional security of the Honduran population, and to provide new guidelines for the determination of vulnerable groups, based on their food risk level (FAO, 2023b). This strategy and related policy were updated in 2019 with the new Policy and National Strategy for Food and Nutritional Security with a 2030 horizon (*PyENSAN 2023,* by its Spanish acronym), with similar goals, but focusing on the access, consumption, and use of foods in adequate quantities, diversity and food safety, to satisfy the needs and preferences, especially of populations in poor and vulnerable situations (FAO, 2023c). Connected to vulnerable groups, in 2017 the country approved its School Feeding Law, with the aim of establishing the legal framework for the State to adequately provide food to children in public schools (FAO, 2020b). This law allowed the creation of the School Feeding Program, which is still operating.

Finally, Honduras is a signatory to the Free Trade Agreement between the Dominican Republic, Central America, and the US (DR-CAFTA). This agreement was negotiated between Central American countries and the United States in 2003-2004 to guarantee free trade among these countries, and the Dominican Republic joined in 2004.[5] Among its many provisions, it established the elimination of tariffs on a list of products, including yellow maize and beans. Currently, after more than 15 years of its implementation, yellow maize (used for animal feed) can be imported into Honduras without tariffs, but white maize (mainly used for human consumption) remains protected,[6] meaning that as Irias et al. (2015) note, white maize can be imported with a tariff (45%). These authors also mention that common beans were protected until year 10 of the agreement (with a gradual reduction of their tariff). Now, common beans can be imported without paying tariffs. According to reports in national newspapers[7] and comments by actors in the bean and maize chains, the reduction of tariffs on beans and yellow maize is a major threat for the national production and for the country's food security, due to the enormous reduction in national production of both grains, and the loss of an important market for white maize in the animal feed industry, for example.

Objectives

This document presents results of a scoping study realized in Honduras between 2022 (production, marketing, and services sectors) and 2023 (food industry sector). The general objective was to identify challenges along the value chains of beans and maize and explore opportunities to innovate. Additional specific objectives included:

- Providing a brief description of the bean and maize value chains in Honduras, including policies and regulations.
- Identify challenges affecting different nodes along the value chains.
- Identify opportunities to innovate or innovations (technologies, practices, methods, etc.) that could help alleviate existing challenges.
- Propose possible interventions to evaluate selected innovations.

We responded to these objectives from multiple actors' perspectives (producers, farmer associations, traders, government, etc.), for which we collected primary data.

Methods

To achieve the goals mentioned, we conducted a scoping study in Honduras, focusing on the bean and maize value chains. This was a necessary step to identify innovations to pilot in the field in 2023 and 2024, and assess their potential for, and trade-offs associated with bringing these innovations to scale. During a CGIAR initiatives with incidence in Honduras launching event (July 1, 2022), the Rethinking Food Markets initiative organized two working groups to gather initial information about bottlenecks and innovations in the coffee, and bean and maize value chains. In the basic grains group, representatives of seven

[5] https://www.cepal.org/es/publicaciones/5001-dr-cafta-aspectos-relevantes-seleccionados-tratado-reformas-legales-que-deben
[6] https://www.trade.gov/country-commercial-guides/honduras-agriculture
[7] https://www.tunota.com/honduras-hoy/articulo/honduras-pide-renegociar-tratado-proteger-agricultores-2023-01-31

organizations participated. This was an exploratory activity that, together with the review of secondary information, informed our strategy to implement this scoping study (especially topics to pay attention to when interviewing key informants). This small group of stakeholders identified bottlenecks and corresponding solutions in five key areas: production, institutional grain purchases, migration and labor, niche markets, and policies. The rest of this section is organized in three parts. In part 1 we describe our strategy for secondary data review; in part 2 our conceptual framework; and in part 3 how we did the primary data collection and validated these results with stakeholders.

Desk review

We did two rounds of literature review. The first one before conducting the interviews with key informants and the second one after the interviews were finalized and data analyzed, and we cite these references throughout this document. The objective of the first round of literature review was to learn about what bottlenecks or challenges actors along staple value chains (especially beans) face, what has been done in terms of interventions aimed at easing these constraints, and the structure of the bean value chain in Honduras (to develop our conceptual framework). This helped us narrow down the topics with information gaps, informed the preparation of an instrument for data collection, and informed our stakeholder sampling strategy (for interviews). For this, we first did an online search using different search tools (Google, Google Scholars, Scielo, CGSpace, IFPRI and Elsevier). The keywords used for these searches included, in Spanish and English: value chain, contract farming, seed, product losses, policy, biofortified, and industry. These keywords were independently combined with the crop-related keywords (beans and maize). Further, these were also combined with the region of interest (Central America) and the country of interest (Honduras; though we also included Guatemala, as it is a second country of interest where we plan to expand our activities).

Second, once we identified strategic publications, we did an additional detailed search in ReliefWeb, ECLAC, Zamorano, IICA, WFP, FewsNet, Weseedchange, World Bank, and other web pages. These were selected because they were related to the publisher or the organization where the authors had published the references found, or where they work, and to explore whether we could find additional relevant publications. We also established search alerts for new information related to beans and maize, independently for Honduras and Guatemala.

In this first round, we reviewed 89 references, which comprised 12 books, 1 book section, 4 theses, 10 web pages, 36 consultancy reports, and 21 peer-reviewed articles, among others. The peer-reviewed articles mostly related to value chains (4), policies (2), biofortified crops (3), product losses (3), contract farming (1), seed systems (1), industry (1), and other topics (6) like migration, climate change, drought, and landscape management. Many of the references found focused on the plant breeding process and were not considered for this study. This stage provided valuable information to plan the interviews with key actors, as they allowed us to better understand the sub-sectors of interest.

The purpose of the second round of literature review, which we conducted after finishing the interviews with experts in the value chains and analyzing the data, was to gain a deep understanding in specific topics with research potential, and that were repeatedly mentioned by key informants. Thus, this review focused on four main themes: contract farming, labor shortage, alternative markets, and financing. The search tools used were Google Scholar, Elsevier, and Sourcely (an artificial intelligence that identifies topics from an idea or text and searches the largest dataset in the world to find relevant and reliable sources). We reviewed 67 scientific (peer-reviewed) articles, 33 focusing on contract farming, 32 on labor shortage, 9 on alternative markets, and 4 on financing. Several articles covered multiple topics. Further, a strategy to obtain more articles about labor shortages by using articles that focused on increasing crop productivity was implemented, which implicitly suggests a lower demand for labor. We cite the most relevant references from both rounds of literature review throughout the document.

Finally, we also consulted national official statistical sources from Honduras, but these presented inconsistent (incomplete) information over time. Thus, for historic data, we rely on the FAOSTAT database.

Conceptual framework

For our conceptual framework, we followed the value chain model of the market systems approach.[8] In this model, a market system is a multi-player arrangement that includes the core function of exchange of a goods and services in the middle, and supporting functions and rules and regulations in the top and bottom. For simplicity, we illustrate our conceptual framework with the type of actors that are involved in the value chain (Figure 5). The information presented in the figure comes from data

[8] The Springfield Centre (2015) The Operational Guide for the Making Markets Work for the Poor. (M4P) Approach, 2nd edition funded by SDC & DFID Available here: https://www.springfieldcentre.com/the-operational-guide-for-making-markets-work-for-the-poor-2nd-edition/

collected from key informants by five of the authors of this study, for a different study conducted in 2022, which is not publicly available.[9]

In the figure, the core of the value chain (middle) includes actors that exchange beans and maize grain, and services. It includes input suppliers on the left and ends with consumers on the right. Input suppliers sell inputs to producers. Once the grain is produced, it is sold to collectors (associations, intermediaries, etc.) and/or the processing industry. As described above, the processing industry is larger for maize than for beans. The grain is then sold to wholesalers and retailers, until it reaches final consumers. Two additional actors can be included in the wholesaler's category: IHMA, who purchases grain and sells it at retail; and the WFP, who purchases grain for the school feeding program. The export of grain can be done by farmer associations or wholesalers. At the top of the figure we find the support service providers, which includes actors providing financial, transportation, research, and technical assistance. Some producer associations and guilds; and buyers, processors and sellers also provide these services. These actors contribute to improving production, marketing and food processing processes. At the bottom of the figure we find the rules and regulations of the country that underpin the various activities of the chain. Policy decision-makers and other value chain stakeholders are involved in policies and regulation processes. The role that development agencies and research centers play can be described both as support services, but also in the policies and regulations environment. Further, these types of actors are the ones that are usually directly involved with actors in the core of the value chain (providing services, technologies, etc.)

We used this diagram as our conceptual framework, as it allowed us to identify the main types of actors we needed to interview, where we could identify potential innovations (production, marketing, processing, policies, etc.), and how these innovations would input into these market systems. Using this framework, we divided our work into three components: the production, marketing and services component (component I); the food processing industry component (component II); and the policies and regulations component (component III). In the remainder of this document, we follow this structure to present results, and the progress to date is different for each component.

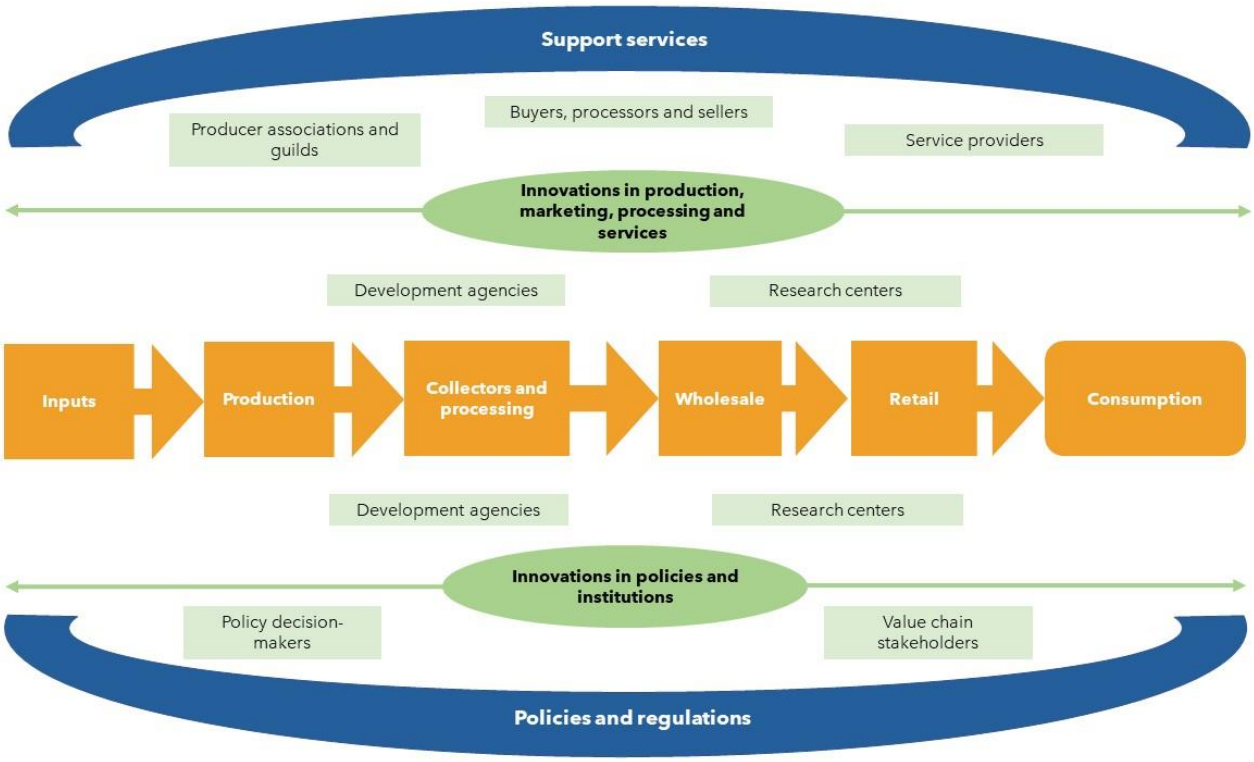


Figure 5. Conceptual framework for beans and maize in Honduras: value chains

[9] The study was commissioned by the World Food Program.

Primary data collection

We collected primary data in two phases. In 2022, we interviewed key informants with different roles along the production, marketing, and few support services nodes of the value chain (component I). In the second phase (2023), we interviewed key informants from the food processing industry (component II). Due to factors out of our control, we have not been able to make progress in the policies and regulations component (component III); thus, we do not provide further details about this component.

Production, marketing, and support services

We interviewed key experts in production, marketing/trade, and support services of the bean and maize value chains. For this, we prepared semi-structured data collection instruments specific for each type of actor, identified a sample of actors to interview, carried out the interviews, processed and analyzed the information, and validated the results with stakeholders. The focus of the interviews was to collect data about challenges and innovations in the value chains of interest, and context information about the sectors and the organizations the informants represent. We followed these main steps:

- Identified the key nodes (links) along the value chain (see conceptual framework), which defined the type of actors we needed to sample. We identified 7 types of actors for interview: producer associations, institutional buyers, financial institutions, research institutions, intermediaries and wholesalers, government officials, and development agencies. We excluded individual producers because we wanted to focus on post-production nodes and did not have the resources to draw a representative sample of farmers for interview. However, we captured challenges and innovations on the production side from the information provided by all types of informants, as most referred to the production sector in their responses (especially producer associations). Further, government officials were interviewed according to the role they perform (institutional purchases, research, etc.), as opposed to preparing a single data collection instrument to use with all government officials (which would have not been adequate).
- Prepared a comprehensive list of names and contact information of actors in most of these nodes (our sampling frame) to sample from. For this, we used existing contacts identified for previous research projects the authors have implemented in the same value chains, and from public information (online). However, we did not have a sampling frame for intermediaries and wholesalers, as we could not find an official registry for these types of actors. Thus, our strategy to sample them was to use contact information we already had from previous work (for intermediaries), and to visit the main markets in the main cities and randomly sample them (for wholesalers).
- We sampled actors in each node, using a mix of purposive and random sampling. The number of actors sampled from each node was (as much as possible) proportional to the number of actors in the population of each node. Further, we identified the main bean and maize producing regions in the country, and the main markets in major cities, to include in the sample.
- We prepared seven data collection instruments, one for each type of actor. Although all instruments included a set of identical questions, they also had specific questions that applied only to the role each type of actor plays in the value chain. Interviewing intermediaries and wholesalers was challenging, as most did not respond to our attempts to schedule an appointment.
- With the sample of actors to interview defined, we proceeded to schedule the interviews.

Prior to the field work, we obtained institutional review board approval from CIAT. We did 33 face-to-face interviews between November 7-18, 2022, and 49 people participated in these interviews (Table 4). As shown, our sampling frame consisted of 172 actors, and most were producer associations. From these, we sampled 39 informants (for intermediaries and wholesalers, we defined a target of 10 actors for interview). The sample came from actors located in the departments of Cortés, El Paraíso, Francisco Morazán, Olancho, Santa Bárbara and Yoro. The route used to interview the sampled informants is highlighted in Figure 6.

To validate findings for this component, we organized a workshop with stakeholders on December 13, 2022. We invited 52 stakeholders (including interviewed and not interviewed actors) from which 25 participated, representing 14 organizations. Reyes et al. (2023a) details the outcomes of this workshop. On it, we presented findings from the interviews conducted with key informants and validated these findings with participant stakeholders. In general, stakeholders agreed with the findings.

Table 4. Production, marketing, and support services sample overview

Type of actor	Sample frame (#)	Identified sample (#)	Interviewed actors (#)	Interviewed people (#)
Producer Associations	132	9	9	17
Institutional Buyers	3	3	3	7
Financial Institutions	6	7	5	8
Research Institutions	8	4	4	5
Intermediaries and Wholesalers	0	10	6	6
Government*	14	0	0	0
Development Agencies	9	6	6	6
Total	172	39	33	49**

Source: Authors

** Government actors interviewed according to their role (e.g., institutional buyer, research).*

*** # interviewed people is higher than the # actors interviewed because more than one person participated in some interviews.*

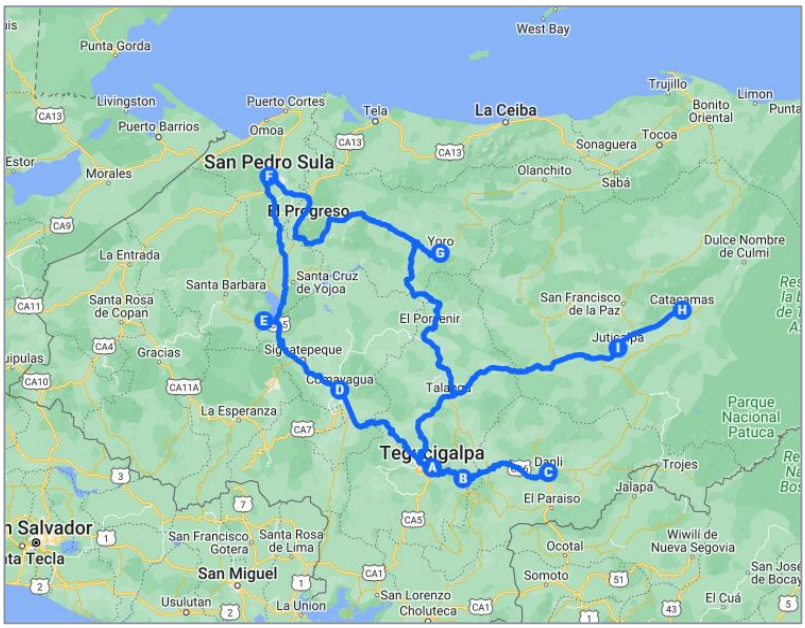


Figure 6. Field route followed to conduct interviews with key informants in 2022, Honduras

Food processing industry

The objective of this component was to explore the innovation potential of small and medium-sized enterprises (SMEs) processing maize/bean-based foods in Honduras. This activity was a collaborative effort with the Agro-industrial Engineering Program of the National Autonomous University of Honduras (UNAH). By examining the role and impact of processing SMEs in these value chains, we seek to provide insights into the opportunities for innovation and development within the agricultural sector.

The design contemplated the identification of innovations in five dimensions: 1) innovation in the supply of raw materials, 2) innovation in the formulation of products, 3) innovation in production processes, 4) innovation in marketing, and 5) innovation in external links. The research questions posed to identify the different types of innovation implemented by SMEs were: 1) What are SMEs processing maize and beans innovating in? 2) What have been the achievements to date with the innovations implemented? What innovations have not given the expected results? 3) What are the plans and challenges for innovation of SMEs?

Between August and September 2023, primary information was collected from 30 SMEs producing processed foods based on maize and beans. This sample was randomly selected from a database of 150 SMEs constructed in 2022 by tracking processed foods based on maize and beans in shops and supermarkets in the country. Table 5 provides an overview of the main characteristics of the sample.

Table 5. Food processing industry sample overview

Variable	Details
Size	**Sample:** 30 SMEs (70% maize processors, 17% maize and beans, and 13 just beans)
Location	**States:** El Paraíso, Francisco Morazán, Comayagua, Cortés, and Yoro
Processed products	**Maize:** flour, tortillas, tamales, snacks, drinks, bread, and others **Beans:** mashed red beans, cooked whole beans
Requirements	Legally constituted SMEs that process and package maize and bean products

The interviews were conducted in person, using a semi-structured questionnaire with closed and open-ended questions within the framework of the five dimensions mentioned above. The participants were generally the owners of SMEs. Only in the case of larger SMEs did a representative appointed by the owner participate. The data collection team consisted of one interviewer and two note-takers. The preliminary results of this component were validated with stakeholders in a workshop done in November 2023. Reyes et al. (2023b) summarizes the outcomes of this workshop. In general, stakeholders agreed with the results presented for the industry sector and suggested additional research ideas to consider.

Results

Challenges and potential innovations in production, marketing, and support services

We next present results from the key informant interviews realized, and structure the challenges and innovations according to the nodes along the value chain we focused on. First, on the production side, then on the trade side, followed by financial and research services. We asked each type of informant to provide information for all the nodes in the value chains, but not all had this information, as they reported now knowing enough. Thus, the number of responses varies by node. These results are the first step to identify potential innovations for evaluation, as they narrow our research topics, and the final innovations will be defined after further consultation with potential partners in the implementation of the pilot evaluation study.

Production node

Four types of respondents provided information about challenges and innovations in the production node: producer associations, development agencies, institutional purchases, and research. Of all responses, the most common challenges reported in the production node were the high cost of production and the lack of equipment and infrastructure, followed by limited financing, lack of technical assistance, land-related challenges, low prices and speculation, climate-related challenges, market access and contracting, low quality, among others (Table 6).

Regarding the high cost of production, informants reported this has happened because of the increase in the cost of fertilizers, pesticides, seeds, and labor (related to migration and lack of interest from youth to get into agriculture which increase its cost due to decreased supply). The lack of equipment and infrastructure has different dimensions and effects, as it relates to planting, irrigation, processing and storage equipment and infrastructure, which in part happens because of lack of financing, forcing farmers to sell immediately after harvest (at low prices), as they cannot condition and store the grain. Challenges with financing relate mostly to accessibility and affordability, as existing options are expensive, which makes farmers secure financing from informal sources, many times using their harvest as collateral. This challenge was reported by CEPAL (2017), who pointed that access to financial services is limited due to lack of financial information on the sector, limited land ownership, lack of collateral, limited and unstable incomes, the high dispersion of farmers in rural areas, the scarce link between small producers and value chain actors, and the lack of technical assistance services to strengthen the sector.

The lack of technical assistance can be explained by the lack of extension services in the country, which is the reason why these services are provided by farmer associations and other types of (development) organizations. Rodriguez (2012) reported that some of these actors have provided technical support (knowledge, inputs, loans) using different mechanisms, including farmer field schools, local agricultural research committees (CIALEs, by its Spanish acronym); development projects, and government-supported input subsidy programs.

Two additional aspects worth mentioning are related to each other, and with other challenges mentioned. Lack of access to better markets and grain quality are directly related, as most of these differentiated markets have standards that need to be met, including specific quality requirements. Solving some of these issues will contribute to solving other issues listed. For example, investing in infrastructure will contribute to overcoming climate-related issues; and providing technical assistance can contribute to improving grain quality, which in turn can open access to better markets to sell the harvest.

Table 6. Challenges in the production node

Challenges or bottlenecks	Production node
High cost of production	13
Lack of equipment and infrastructure	10
Limited financing	7
Lack of technical assistance	6
Limited access and land use change	5
Low price and speculation	5
Climate-related challenges	5
Markets access and contracting	4
Low quality of grain and seed	3
Access to water and irrigation systems	3
Crop pests and diseases	3
Organizational and associativity problems	3
Other*	16
Total	**83**

Source: Key informant interviews
**None of the challenges reported in "other" had more than two mentions.*

We also inquired about challenges that farmer associations face, and three types of respondents felt they could list some of these: representatives from farmer associations, institutional purchases, and research. The challenges faced by associations are like the ones faced by producers, though in different dimensions. The two most important challenges for associations are the limited access to financing and lack of infrastructure and equipment. However, while for farmers, financing is important to finance production and some post-harvest activities, for farmer associations it was to finance large investments in processing infrastructure and for grain purchase. Another challenge relates to technical assistance, mostly about having resources for them to provide technical assistance to farmers, but also receiving technical assistance related to organizational aspects, new technologies, how to access better markets, and improving record-keeping at all levels. Two additional challenges are the lack of long-term business vision by member farmers (which is visible because they sometimes do not honor their commitment to the association, like the amount of grain to sell), and organizational and associativity challenges. Like in the production node, investing in easing some of these challenges will contribute to solving other limitations.

The solutions or innovations that can be considered to resolve issues in the production node include improving financing, improved varieties, providing technical assistance, increasing the use of digital tools, improving the quality of and access to inputs, better production, and marketing mechanisms, among others (Table 7). Improving financing goes beyond access and affordability, as informants suggested that it is necessary to strengthen existing low-cost mechanisms (like Banadesa, the national agricultural development bank) and considering alternative mechanisms (like rural banks). Informants mentioned that the most needed traits from improved varieties are tolerance to climate-related factors (drought, high temperature), better adaptability to diverse production environments, resistance to pests and diseases, and high productivity. Technical assistance is needed regarding the use inputs, how to manage production systems to repay loans, and technical assistance on organizational aspects.

Table 7. Solutions or innovations in the production node

Solutions or innovations	Production node
Improve financing	8
Improved varieties	5
Technical assistance	4
Greater use of digital tools	4
Improve quality of and access to inputs	4
Better production and marketing mechanisms	4
Grain price	4
Equipment and infrastructure	3
Implement good agricultural practices	3
Irrigation systems	3
Other*	34
Total	**76**

Source: Key informant interviews

**None of the innovations reported in "other" had more than two mentions.*

Marketing/trade node: regular market sales, institutional purchases, and wholesale

We separate responses about regular marketing channels from institutional purchases and wholesale because the institutional purchases market is not easily accessible by any provider and has specific requirements that differentiate it from regular (traditional) marketing channels; and wholesalers (who provided their view about challenges they face when trading grain) were reluctant to respond to a formal interview, which forced us to collect concise information[10] in a conversational way (instead of an interview).

Three types of respondents provided information about challenges when selling in regular marketing channels (development agencies, institutional purchases, and research) and four types provided information about solutions or innovations when selling in these markets (the same three listed plus farmer associations). Of all responses, the most common challenges reported were the limited access to financing and lack of adequate facilities, followed by low grain quality, limited certification capacity, and other challenges (Table 8). Although informants did not provide too many details about the two main challenges, financing was mentioned as a limitation because it is needed to purchase large volumes of grain and is not easily accessible, and because the type of financing needed sometimes is different than the traditional loans available (e.g., bridge financing). The limitations in facilities include drying and storage facilities for large volumes. As we can see, these limitations are most likely faced by large buyers (like associations and large intermediaries), although smallholder farmers certainly face them, albeit on a smaller scale.

The solutions or innovations that can be considered to resolve issues in regular marketing channels include improving infrastructure, better production and marketing mechanisms, international markets, and providing training and support to organizations, among others (Table 9). Regarding infrastructure, informants reported this is needed at different levels. For small volumes, simple and more complex storage technology is needed, like sacks and metal containers (*silos*). For large volumes, expanding and improving collecting facilities is needed, as well as increasing the grain conditioning capacity of existing facilities. Innovations in marketing mechanisms include direct purchases from local groups (*mancomunidades* and rural banks), purchasing contracts with the industry (for maize specifically), and general purchasing contracts. In the case of international markets, there are innovations already incorporated, like exporting beans to the US for the nostalgic market (Honduran nationals living in the US), although informants mentioned needs to be expanded. They also mentioned the need to increase local capacity for exporting beans. Since the country is a net maize importer, international markets were not suggested as a priority for that crop. Finally, organizations need training and support, and some of the topics mentioned by informants were managerial support for seed production and training about marketing strategies.

[10] Meaning we only asked about challenges and solutions/innovations to these respondents.

Table 8. Challenges in regular markets

Challenges or bottlenecks	Regular Markets
Limited access to financing	2
Lack of adequate grain collection facilities	2
Low grain quality	1
Limited certification capacity	1
Road quality makes it difficult to purchase grain	1
Limited quality laboratory capacity	1
Low legal trade (using invoices)	1
Traders lack knowledge about new varieties	1
Unstable supply of grain	1
Unstable prices	1
Bureaucratic challenges to obtain operational permits	1
Do not know	4
Do not respond	3
Total	**20**

Source: Key informant interviews

Table 9. Solutions or innovations in regular markets

Solutions or innovations	Regular markets
Collecting, conditioning and storage infrastructure	5
Better production and marketing mechanisms	3
International markets (beans only)	3
Training and support for organizations	3
Existence of alternative national markets	2
Better financing	2
Grain and seed banks	2
Market information	2
Other*	23
Do not know	3
Total	**48**

Source: Key informant interviews

**None of the innovations reported in "other" had more than one mention.*

Representatives from institutions that purchase grain were the only ones who reported challenges and innovations in institutional markets (which only includes two actors: IHMA and WFP). The main challenge faced by actors in this market is the low grain quality (Table 10). This includes aspects from both supply and demand sides. On the supply side, informants reported that the grain comes with pests. On the demand side, they said they have a poor reputation because consumers perceive the grain sold is old (hard).[11] The remaining challenges are self-explanatory. The innovations and solutions in place include bean purchasing agreements (currently with communities in the departments of Lempira, El Paraiso and Yoro), the need to invest to reach all schools in the country with high-quality foods, and the need to provide school-aged children with a more balanced diet (Table 11).

[11] Consumers prefer "fresh" grain, meaning a grain that was recently harvested.

Table 10. Challenges in institutional markets

Challenges or bottlenecks	Institutional market
Low grain quality	2
Limited access to financing	1
Poor institutional reputation due to delayed payments	1
Do not know	1
Total	**5**

Source: Key informant interviews

Table 11. Solutions or innovations in institutional markets

Solutions or innovations	Institutional market
There are purchasing agreements for beans	1
Increase the number of schools with high-quality foods	1
Provide balanced diet to students	1
Do not respond	1
Total	**4**

Source: Key informant interviews

We obtained wholesalers' perspectives (from six informants) about challenges and innovations they face when trading grains. The main challenges faced by these actors are low grain quality, followed by market prices, climate-related challenges, and others (Table 12). The major aspect affecting grain quality is grain moisture, on both extremes (too wet or too dry), which suggests this can be an area for innovation, as in some cases when the grain is too wet, it gets a discount of 13-15 Lempiras per 200-lb sacks (roughly $0.53-0.61 per sack). Other aspects affecting quality are its cleanliness, the presence of mixed grains (different shades of red or different colors), irregular grain size (requires grain selection), the presence of foreign materials (like dirt), and the lack of consistency in grain quality (this can be over time from the same supplier, or across suppliers). Further, this factor is more problematic in the grain they purchase (mentioned eight times), than the grain they sell (mentioned three times), suggesting wholesalers may invest in cleaning and sorting the grain before selling it to consumers. The price effect is variable, and most informants commented on this in relation to beans. For example, some informants reported the price is too volatile, others that the base price set by IHMA is too high,[12] and others that regulating the price creates inefficiencies in the market. Regarding climate-related challenges, informants pointed out that even though these factors directly impact production (irregular production, lower production, etc.), they feel its impact because the grain supply for marketing is irregular (which also affects prices).

Table 12. Challenges in wholesale markets

Challenges or bottlenecks	Purchases	Sales	Total
Low grain quality	8	3	11
Price	3	4	7
Climate-related challenges	2	2	4
Low productivity	2	0	2
Unstable supply	1	1	2
Other*	3	5	8
Do not know	1	0	1
Total	**20**	**15**	**35**

Source: Key informant interviews

**None of the challenges reported in "other" had more than one mention.*

[12] This contrasts with what was reported by suppliers, as they consider this floor price to be too low.

Among the solutions highlighted are investing to foster group production, eliminating subsidies, and other innovations (Table 13). One informant reported that farmers could be organized in groups of 200-300 farmers through associations or local boards ("*patronatos*"), and receive inputs, technical assistance and agroclimatic information as an innovation. This could help farmers improve the quality of the grain they produce, increase productivity, and the volume of grain supplied to the market. Regarding subsidies, informants mentioned that the main issue is that IHMA sets a floor price that is high but sells the grain to consumers at prices below this floor price, which affects the prices in the market.

Table 13. Solutions or innovations in wholesale markets

Solutions or innovations	Purchases	Sales	Total
Increase group production	1	1	2
Eliminate subsidies as they affect competitivity	2	0	2
Other*	5	1	6
Do not know	1	1	2
Do not respond	1	3	4
Total	**10**	**6**	**16**

Source: Key informant interviews

**None of the innovations reported in "other" had more than one mention.*

Support services: financial and research

For financial service providers, we asked different questions than for other actors. For this sector, we were interested in the services they provide, which ones are used most, which ones present the highest risks (including profile of users with highest risk), and what are services that they consider could be used more (Table 14). Five informants provided information. In terms of services offered, they reported seven types of services that could be used for beans and maize, being the most common one direct loans for production. However, there are loans that rural banks can access to, and loans for individuals and groups not subject to credit. Other services available include FOGAFRIJOL, which is a dry beans guarantee fund supported by USDA through its MAS+ project to facilitate agricultural and SMEs lending.[13] Another service includes a weather-indexed financial service (insurance) that has been designed, and where a third-party carries out the monitoring of plots (using satellite images), and is backed by the regional insurance provider MAPFRE. This service corresponds to 2% of one financial provider's portfolio. One provider mentioned they provide a service for the registration of production plots, their monitoring and harvest validation.

Financial service providers reported that the most common service used is loans for production. Although they mentioned additional services, some were not reported as being offered, perhaps because they specifically did not offer them, but knew those services are used by the sector. When asked about which services presented high risk, some respondents opted to report the profile of users that present the highest risk. The services that present a high risk included the direct loans for production and FOMIPYME, which is a government fund to support and develop the competitiveness of MSMEs[14] and mostly used to invest in technification of processes for sales to supermarkets. Further, informants reported subsistence farmers are the type of users that present the highest risk when obtaining financial services, and the risk of default by individual farmers and agroindustry is latent.

Finally, these providers mentioned that among the services that could be used more are loans for production and SENPRENDE, which is the national service for small business entrepreneurship, and that provides technical assistance, financial links, formalization, and market access to these actors.[15]

[13] https://pdf.usaid.gov/pdf_docs/PA00Z3C7.pdf
[14] https://www.andi.hn/wp-content/uploads/2012/11/ley_del_fomento_para_las_mipyme.pdf
[15] https://senprende.com/

Table 14. Financial services for beans and maize in Honduras

Type of service	Offered	Used most	Highest risk	That could be used more
Loans for grain (beans and/or maize) production	2	2	1	1
Mutual guarantee services for individuals or organizations not subject to credit	1	1	0	0
FOGAFRIJOL (from Covelo Foundation)	1	0	0	0
FOMIPYME for technification and sales to supermarkets	0	0	1	0
Weather-Indexed financial service	1	0	0	0
Loans for MSMEs	0	1	0	0
Loans for rural banks (beans and maize)	1	0	0	0
Registration of areas, monitoring, and harvest validation	1	0	0	0
SENPRENDE for associated farmers (not functioning at the moment)	0	0	0	1
Subsistence farmers	0	0	1	0
That payments for services are honored, both by farmers and agroindustry	0	0	1	0
Whole Foods risk funds (specific for beans and associated farmers)	0	1	0	0
Do not respond	0	1	1	3
Total	**7**	**6**	**5**	**5**

Source: Key informant interviews

Four representatives from research institutions were the only ones who reported challenges and innovations in this sector. The main challenge faced in this sector is the limited funding for research. Other challenges reported include the lack of diffusion of improved varieties, the need for generational change (as many researchers are nearing retirement age), the need of networks (to do research and to produce seed), among others (Table 15). Among the solutions suggested, are strengthening the national research programs by providing funding for research, increasing staff and improving their monetary compensation, and improving their facilities and equipment. There is also a need to increase the resources for research, and the amount of seed that is produced (in the latter, there may be opportunities to innovate) (Table 16).

Table 15. Challenges in research services

Challenges or bottlenecks	Research services
Limited access to financing	4
Lack of diffusion of improved varieties	1
Lack of generational change	1
Lack of a network for research	1
Lack of a network for seed production	1
Research is isolated from other nodes in the value chain	1
Lack of training	1
Lack of continuity in research	1
Internal organizational challenges	1
Total	**12**

Source: Key informant interviews

Table 16. Solutions or innovations in research services

Solutions or innovations	Research services
Strengthen the national research program	4
Increase resources	2
Seed production	2
CIALES play an important role in research	1
Invest in machinery	1
Improve internal processes to execute projects	1
Total	**11**

Source: Key informant interviews

From these results, we observe that though there is diversity in the challenges faced along the value chain, there are also several similarities, with differences in relevance. For example, grain quality was more important in the marketing nodes, and less mentioned in the production node, but investments to improve quality in production will be beneficial along the supply chain. Grain price is also an important challenge reported at all levels, as is the need for technical assistance, financing, and better infrastructure and equipment, and investments to reduce production costs (or make this process more efficient).

Challenges and potential innovations in the food processing industry

The results from the interviews with representatives of the food industry sector (conducted in 2023) show that the maize processing sector is much more developed and broader than the bean sector. Therefore, we find that SMEs processing maize products carry out more innovative processes than bean SMEs that only perform basic cooking, grinding, and bagging processing. It is important to note that the largest SMEs that process beans chose not to participate in the study, and this may be one reason why fewer innovations were identified. In comparison, those that process maize are constantly innovating, making significant improvements in developing and transforming their products, processes, and services. Table 17 summarizes how innovation is present in the different dimensions considered for this study.

Table 17. Main innovations implemented by SMEs

Dimension	Main innovations identified
Raw material supply	• Ensure quality and availability of raw materials by collaborating with other companies or suppliers • Own production of raw materials
Product formulation	• Addition of new production lines • Combine different ingredients (natural or industrial colored) • Combine the maize flour with the nixtamal maize dough
Production processes	• Purchase of machinery and equipment to improve technical processes • Modification and construction of processing facilities • New packaging presentations
Marketing	• Direct sales in supermarkets • Expansion of the distribution network (own employees or retailers) • Export of nostalgic products
External links	• Collaboration with other companies to obtain raw materials and processing machinery.

Innovation in raw material supply

Innovation in raw material sourcing was identified in the relationship that maize processing SMEs have with companies in the flour industry, especially with DEMAHSA, the subsidiary in Honduras of GRUMA, Mexico. Most of the SMEs interviewed said they use flour from this company due to the multiple benefits it represents for their business, which allows them to generate innovation by improving the quality of their products and the productivity of their company. Among the main benefits mentioned are the consignment of equipment (tortilla machines and kneading machines), a bonus of raw material according to the purchase volume, credit of up to 30 days (about 4 and a half weeks), and delivery of the raw material at home. Although some continue to use nixtamalized maize (between 10 and 20% of the total raw material used in the process), they have a notable preference for the use of flour, and that, as they mention, allows them to lower production costs since they save labor,

firewood, and equipment necessary for the nixtamalized process and consider that the flour 'yields more.' Another reason why SMEs prefer flour is that the industry offers them different mixtures depending on the products they process, for example, special flour for tortillas, special flour for snacks, and special flour for bread, among others.

The flour industry has a direct link with maize producers. Through a purchase agreement, companies in the sector sign an annual contract to buy national grain with maize producer associations. This agreement defines the purchase volume of each company, which is linked to the volumes of grain they can import. Depending on the availability of domestic grains, the purchasing ratio may vary from 1:3 to 3:3 for imported grains.

Another innovation in the supply of raw materials was found in SMEs that produce processed cob products. Because they need fresh maize throughout the year, these SMEs are responsible for producing most of the raw materials they need or have a verbal relationship with local producers that assures them of the product's availability throughout the year.

Innovation in the formulation of new products

Generally, SMEs processing maize and beans focus on producing traditional products consumed by Hondurans, such as tortillas, tamales, bread, snacks, cob products, mashed red beans, and cooked whole beans. It was identified that some SMEs are innovating by incorporating new traditional products into their production lines. For example, some began selling only tortillas and recently included other products such as chicken tacos and snacks.

We found that some SMEs that make snacks and tortillas are innovating with some blends to change the product's color and flavor, add value, or improve its 'nutritional content.' The product's color is changed using natural dyes (carrot, beets, spinach, and annatto extract) and industrial food-grade dyes. The use of natural dyes is an innovation that has caught the attention of supermarkets and especially final consumers, as the product gives the impression of being more nutritious and healthier.

SMEs that make bread frequently combine flour with nixtamalized maize dough. Depending on the type of bread, there may be 100% nixtamalized maize bread or a mixture that includes between 10 and 20% nixtamalized maize dough and the rest with flour. Adding a low percentage of nixtamalized masa to the mix gives the product a traditional touch of flavor and texture. However, they prefer flour because it reduces production costs, yields more, and they do not pay labor for the nixtamalization process.

Innovation in production processes

Innovation in the production processes of SMEs that process foods based on maize and beans has focused on incorporating machinery and equipment that make production processes efficient. Although we identified that those who process beans are improving production processes with the improvements of some machines, mainly industrial blenders, the process is still artisanal.

Those that process maize are more frequently technician in their production processes. The most common way to acquire machinery is through the link of SMEs with DEMAHSA. Consuming a specific monthly flour volume, they can access consignment machinery (kneading and tortilla-making machines). The second way is purchasing with their funds. In the last five years, we identified SMEs that invested in industrial ovens, automatic bread-making machines, stainless steel tables, sealers, flyers, centrifuges, and other essential equipment. SMEs with greater investment capacity have also built new processing plants. This investment has allowed them to increase their production capacity, make their processes more efficient, and implement the safety programs that most SMEs do not usually implement. The third and least common way is the acquisition of machinery and equipment through loans. Although most SMEs said they did not have access to loans for the sector, one of them bought all their equipment and infrastructure with funds from a project in which 60% was a donation, 20% a loan, and 20% own funds, another is in the process of managing a loan with another NGO with affordable payment conditions.

The most common packaging of maize and bean products is in labeled plastic bags containing basic information that allows them to be differentiated by consumers. The most innovative SMEs are investing in bags with a better design and labels that include nutritional information and some seal that gives them greater visibility (e.g., country brand and women's Entrepreneurship in The Americas). No significant innovations were identified in the preservation of products; preservation is limited to using sodium benzoate and freezing products (for example, mashed red beans). Only an SME that makes tamales carries out a highly technical conservation process, allowing it to preserve its products for over a year.

Marketing innovation

In the last ten years, the leading supermarket chains in the country (Walmart and Supermercados la Colonia) have opened the doors for national SMEs to market their products. More than 50% of SMEs sell in at least one of these chains. Some SMEs already have a consolidated commercial relationship, while others are starting commercial relations.

For other SMEs, marketing in supermarkets has not been necessary. They have created an important market for their products by building their customer network. The leading retail stores in which they sell their products are grocery stores, wineries, markets, and their establishments. One of the most innovative SMEs has established its market in a network of 12 stores located at strategic points such as airports and exits or entrances of the main cities.

Among other innovations, we identified that SMEs carry out different economic activities that together potentiate the commercialization of processed maize and bean products, for example, with restaurants, water parks, and supermarkets. They also complement their economic activity with other production lines, such as dairy products, fruit pulp, and banana snacks. A small group (n=3) has opened an export market for nostalgic products, primarily destined for the United States and Spain, where the largest population of Honduran migrants is located.

Innovation in external links

Innovation in this dimension is limited. The only link that, according to SMEs, generates innovation processes is the one they have with DEMHSA, which, as already mentioned in the raw material supply section, is the one that provides them with a series of services and benefits for the purchase of flour.

We found that more than five years ago, the country's eastern region bakers were organized on a platform that brought together several SMEs in the field. Through this association, they were part of several projects of access to technology (machinery, construction of ecological ovens), exchanges of experiences, and training in administrative issues and safety and hygiene measures for food preparation. Unfortunately, it does not work at present, and each MSME operates independently.

Limitations for innovation by SMEs

Even though SMEs generate innovation processes to improve their operations, products, and services, and they are essential for economic and social development and job creation, most face various challenges to their growth, innovation, and competitiveness, such as:

- Limited infrastructure: The infrastructure in terms of space and minimum conditions for compliance with good manufacturing, hygiene and occupational safety programs is lacking in most of the SMEs visited.
- Noncompliance with GMP programs: Although many mentioned that they were complying with these and that it was required, especially for those supplying to supermarkets, it is possible to observe an apparent failure to comply. Due to lack of adequate infrastructure, lack of training, lack of inspection by competent authorities and lack of will, most SMEs do not comply with these programs.
- Low level of productivity: Demand exceeds supply for more than half of the SMEs surveyed. Their low productivity is related to lacking infrastructure, equipment, or technology that allows them to increase their capacity to produce.
- Low use of food preservation techniques: At least half of SMEs do not use food preservation methods. They usually produce what will be sold in the next few days. More traditional methods are the use of sodium benzoate, especially for maize products, and freezing for bean products. Food preservation becomes a constraint mainly because it shortens the shelf life of products, which reduces retailers' purchasing volumes, and SMEs must produce and deliver more frequently, which increases their operating costs.
- Low use of promotional activities: Most SMEs, especially the smaller ones, do not carry out promotional activities such as tasting in supermarkets, placing banners, delivering propaganda, using social networks, radio and television commercials. Only SMEs that sell in supermarkets carry out some product tasting activities and place products on offer. One of the reasons why some SMEs have stopped using social networks to promote their products is because they have received extortion threats.
- Limited access to finance: SMEs often faces difficulties in obtaining financing for their innovation projects due to the lack of guarantees, high interest rates, bureaucracy or the scarcity of financial products adapted to their needs.
- Lack of public security: Some SMEs prefer to operate in the shadows to avoid being targeted by extortionist criminals.
- Limited access to support programs for the sector: Currently, no project in the country offers training services or technical assistance for administration and production. The lack of information limits innovation, especially for new entrepreneurs.

We also identified challenges that affect innovation in the overall maize and bean chain, such as:

- Limited direct link of SMEs with grain producers: There is little opportunity for producers to access a direct market with SMEs because most use flour or buy maize and beans directly from intermediaries. In the case of the maize chain, the flour industry buys maize from producer associations. Whereas in the bean chain, the bean is purchased only from intermediaries. For SMEs, buying from intermediaries is their best option because they say their purchase volumes are low, and intermediaries assure them of the quality and availability of the grain.
- Dependence on a single company: The use of flour almost exclusive to a brand has allowed them to generate innovation. This type of dependence has also created a loss of bargaining power, especially when they must meet the monthly purchase quotas to be able to make use of the machines on consignment. On the other hand, some SMEs have also limited innovation by being unable to access other alternatives or suppliers of raw materials. For example, this could be the primary constraint for producers to link with SMEs directly.
- Low interest in the use of grain maize for processing: Most SMEs are not interested in increasing the use of grain maize because, according to their perspective, carrying out the nixtamalization process generates higher costs in hiring labor and do not have the space or equipment for cooking and milling maize.

Finally, we asked some of the informants who we interviewed for the production, marketing, and support services component (in 2022) to state challenges they knew the food processing industry faces. Though only three types of informants knew about this sector (producer associations, development organizations and research),[16] they stated that the main challenges this sector faces were grain quality, the effects of imports, the grain supply, and prices, among others. Regarding quality, the main challenge is the low quality of the grain the industry can obtain in the market, especially at the required volume, and with the required consistency. This is due to many factors, including lack of grain conditioning equipment. Imports present several challenges, including the effect of illegal imports (lower price, given they do not pay import tariffs)[17] from neighbouring countries, the preference from the sector to import (mostly yellow) maize due to its lower price, and the lack of consistency in the local supply (unreliable), all of which make national production uncompetitive. The challenges in grain supply relate to the limited volume the national production can consistently supply, which in part is explained by the fact that most (white) maize locally produced is for household consumption, selling only surplus, when available. The challenges with prices related to the industry wanting to pay low prices (in part because they can import grain at lower prices), although the prices paid are more constant over time.

Potential innovations to evaluate

In the production, marketing, and support services

For this component, we propose general innovation topics to consider for evaluation, which will be further refined with consultations with organizations that will partner in the pilot evaluation study, to tailor the final innovation bundles to their needs. Further, we propose to focus on beans only, as some informants suggested doing the pilot on beans, because of its greater potential for impact.

1. Technical assistance for production and quality

This intervention aims to innovate in the technical assistance provided to producers, by farmer associations. In recent years, this service has been deficient due to the lack of a formal rural extension system in Honduras. Thus, delivering latest research outputs has relied on development agencies and farmer groups. Among the benefits of this intervention are that if producers receive technical assistance, they will adopt some of the technologies and practices included in such assistance, which will allow them to increase their production, produce better grain quality, and obtain better prices. The benefits for farmer associations are that, by having a greater and better supply of grain, they can reduce their processing costs, access better markets, negotiate prices based on quality, and obtain higher income. Reardon and Timmer (2007) reported that producers have been able to coordinate with supermarkets and food distributors to implement new standards and requirements due to changes in demand, which highlights that implementing innovations aimed and increasing quality is feasible. Although these authors mentioned that this was possible through contracts between producers and a distributor, others have found mixed results of the effect of contract farming on farmers. For example, Khan et al. (2019) found positive results when the crop

[16] For that component, we did not have representatives for the industry sector, but we include responses from other types of respondents here as it relates to the industry component.
[17] One respondent reported that roughly 3,000 MT of maize flour are illegally imported.

negotiated has high value, but no effects when it is a staple crop with little room for quality improvement. Ragasa et al. (2018) fond that in Ghana, though contract farming had a positive effect on technology adoption and yields, it had a negative effect on farm benefits. Soullier & Moustier (2018) found that production contracts had a positive impact on the income of producers excluded from bank credit, though these farmers obtained smaller benefits compared to producers who are financed by the formal banking system. Thus, although evaluating the effect of contract farming together with this innovation can be an interesting research question, we propose to focus only on technical assistance, and leave contract farming for future research.

Implementing this innovation would carry out costs, both for producers and for farmer associations providing this service. Farmer associations will need to develop a (or improve existing) training curriculum and carry out the training (which requires human and financial resources). Farmers may incur costs if they decide to adopt some of the technologies or practices taught in the training sessions. It will be key to do a cost-benefit analysis of this intervention.

2. Quality and market information for marketing decisions

We propose to conduct on-site quality testing, so farmers learn about the quality of the grain they produce, and any discounts applied to their grain because of quality. We can pool this innovation with providing market information (mostly price) to farmers. These innovations combined can influence farmers' decision about where to sell, and how much to sell. We can implement these together with farmer associations, who would lead field activities. With this bundled innovation we will analyze its effect on the producers' marketing decisions, focusing on the impact on sales to farmer associations.

The benefits of the intervention will be that, if farmers know the quality of their bean harvest on site (either on farm or at home, depending on where the grain is stored), and the market price, and if this information is provided by the farmer association, they can decide to sell and to sell a larger volume to the association, to obtain higher incomes. This will benefit the association because they will have a larger volume of known quality beans sold by its members (thus reducing the need to purchase beans of variable quality in the market) and can input that information (that comes from the field) into their collection routes, making the transportation process more efficient. Further, they can separate batches of grain to condition them for different marketing channels (with different quality requirements), making the marketing process more efficient.

Farmer associations will bear most of the associated costs of this innovation, as it requires building capacities to do reliable on-site quality testing, on-site record keeping, live transmission of information (via App), equipment, and supervision of staff responsible to implement it. Farmers may face small costs, as they will need to dedicate time to be present during the quality testing.

3. Traceability and record-keeping systems to connect suppliers and buyers

Informants reported the need to increase the use of digital tools. One innovation in this area can include launching an information system for traceability of grain, mostly focused on identifying producing regions (and farmers specifically) with potential buyers. There is a similar experience done for maize, where a third-party collects information about maize suppliers and makes it publicly available for potential buyers to connect with them (through this third-party, who coordinates the trading negotiations). This will require adapting an existing innovation or developing a new one to register farmers' bean plots, collecting and reporting information during the production cycle, and anticipating harvest volumes so potential buyers can connect with potential suppliers. It will also require a third-party to coordinate all activities, which could be a financial service provider with experience in this area.

Farmers, third-party stakeholder, and buyers will benefit from this innovation. Keeping detailed records of activities done during the production cycle would allow farmers to know their profits and reduce the need to search for potential markets for their harvest. It is expected that farmers will be able to increase their incomes, as they will be selling directly to the final buyer, instead of intermediaries in their communities. The stakeholder who will coordinate this will benefit from charging a fee for their 'brokering' service, which will most likely be used to cover the costs associated with the successful implementation of this innovation. Buyers will benefit because they will be able to monitor the production during the crop cycle, will be able to trace the grain, and reduce the need of a middlemen to source their grain needs, hence potentially reducing their purchase costs, increasing their profits.

The main costs of this innovation relate to the design, operation and maintenance of the tool that will be used (either an app, a server, or a combination of both), the monitoring of field activities, analysis of information, capacity building (training staff, etc.), and the marketing transactions between suppliers and buyers. We suggest conducting further consultations with relevant stakeholders to better design a pilot study in this area. The costs will be incurred mostly by the stakeholder implementing this innovation (most likely the third party).

4. **Technology aimed at reducing labor demand**

This innovation aims to bring technologies that can be practical and accessible to producers to make the production process more efficient by reducing labor demand. Specifically, a mechanical seeder has been identified because of its low cost and potential to reduce labor demand during planting, in addition to other benefits. This innovation can be implemented with the collaboration of farmer associations. If producers or producer organizations have access to this technology, they can reduce the time needed to plant beans, which is important because of shortage of labor in the region due to increased migration; and the number of people needed to plant a bean plot. Christiaensen et al. (2021) reports that societies evolve from having a surplus to a shortage of national agricultural labor, and this shortage is usually partially satisfied by foreign agricultural workers. Although this is still the case in Honduras (where Nicaraguans sometimes migrate to work), it is now less frequent, given that most nationals from countries in the region migrate outside Central America.

Since less labor is demanded, the planting cost may decrease (will need to be compared with the cost of acquiring and maintaining the technology). Further, farmers will be able to plant seeds more uniformly (same dept, distance, number of grains per site), which will translate into a uniform plot that will be easier to manage. This could have an impact on grain quality and production. If quality and production increase, farmers income will increase.

However, farmers will need to pay for this technology, which may be too expensive for small farmers; and they will need to be trained on how to use and maintain it. Acquiring the technology may require providing financial services to farmers to buy it, which will have costs associated with this (interest, risk of default, etc.); or farmer associations purchasing the technology and providing the renting service to farmers (which will also have additional costs associated with this). Implementing this innovation will require a cost-benefit analysis (to determine when farmers or farmer associations would recover the investment), and the evaluation of the impact of it may need to be carried out over more than one season.

In the food processing industry

The maize and bean-based food processing industry in Honduras has great potential for growth and development. Maize and beans are not only important staples in the Honduran diet but also serve as significant sources of income for many SMEs in the country. In 2024, with the aim of further developing this industry, we propose piloting three innovations that focus on product design to drive value chain development by SMEs.

1. **New tortilla chips based on higher quality flour**

The aim of this innovation is to assess the physical, organoleptic, and nutritional properties and consumer acceptance of new maize snacks combined with different ingredients that add nutritional value or improve product quality. Some options could be I) multigrain tortilla chips with flaxseed and Chia, II) tortilla chips with vegetables II) tortillas with beans and, IV) tortilla chips with black maize.

To evaluate the physical properties of the new tortilla chips, we will measure color, texture, and crunchiness using standard methods. Organoleptic properties, including taste, aroma, and general acceptability, will be evaluated through sensory evaluations. Additionally, nutritional properties, such as protein, fiber, and omega-3 fatty acid content, will be determined using standardized laboratory techniques.

2. **Maize flour based on higher quality maize grain**

This innovation aims to evaluate the characteristics of maize flour formulated from nationally produced grain, specifically tailored for the industry of tortillas and snacks. Some options could be: 1) black maize flour and II) White maize flour made with domestically produced grain.

To evaluate the industry properties of the new flour, we well measure particle size distribution, color, moisture content, and bulk density.

3. **New packaging for mashed red beans**

This innovation aims to explore the potential of innovative packaging for red bean mash. We will not only focus on the packaging aspect but also evaluate the market expansion potential and consumer interest in purchasing red bean mash packaging in tetra packs or stand-up pouch-type containers.

To evaluate the consumer interest in purchasing this new packaging we will use the Home Use Testing (HUT). It involves recruiting consumers to test a product or prototype in their own homes, providing valuable insights into its usability, functionality, and overall user experience.

Finally, the implementation and design of the pilots will be carried out in 2024 by a multidisciplinary team from UNAH, CIMMYT and consultants specialized in food technology and sensory analysis. The design will include elements to determine the

physical, organoleptic and nutritional properties of the products. It will also include a sensory analysis to evaluate consumer acceptance.

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Annexes

Annex 1. Exports, Imports and trade balance for beans and maize in Honduras

Crop	Variable	2018	2019	2020	2021	2022	Average	Std. Dev.	Coeff of Var
Beans	Exports (MT)	3,970	2,538	2,080	2,048	1,962	2,520	841	0.334
	Imports (MT)	15,467	15,507	14,665	15,384	20,771	16,359	2,491	0.152
	Trade balance	-11,496	-12,969	-12,585	-13,337	-18,809	-13,839	2,862	-0.207
Maize	Exports (MT)	999.9	623.8	834.2	3,590.7	3,678.8	1,945	1,548	0.796
	Imports (MT)	634,440	691,370	759,899	751,933	1,042,691	776,067	157,452	0.203
	Trade balance	-633,441	-690,746	-759,064	-748,342	-1,039,013	-774,121	156,366	-0.202

Source: FAOSTAT (2023). Trade balance (exports - imports) estimated by the authors.

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