The Sierra and the Coast:
An Assessment of Seed Systems Used by Farmers in Two Regions of Ecuador

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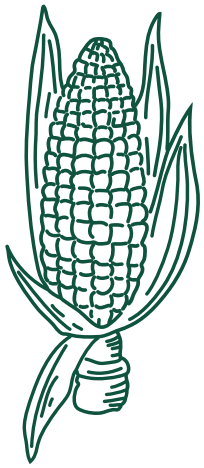

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List of acronyms

Acronym	English	Spanish*
AFC	Subsecretariat of Family and Small-Scale Farming	Subsecretaría de Agricultura Familiar y Campesina
BOLD	Biodiversity for Opportunities, Livelihoods and Development Project	
CBDA	Agrobiodiversity Bioknowledge Centres	Centro de Bioconocimiento de la Agrobiodiversidad
CCMU	Women's Central Committee of the Union of Campesino and Indigenous Organizations of Cotacachi	Comité Central de Mujeres de la Unión de Organizaciones Campesinas e Indígenas de Cotacachi
CIAT	International Centre for Tropical Agriculture	Centro Internacional de Agricultura Tropical
CIMMYT	International Maize and Wheat Improvement Centre	Centro Internacional de Mejoramiento de Maíz y Trigo
CIP	International Potato Centre	Centro Internacional de la Papa
CESA	Ecuadorian Centre for Agricultural Services	Central Ecuatoriana de Servicios Agrícolas
COESI	Organic Code on the Social Economy of Knowledge, Creativity and Innovation	Código Orgánico de la Economía Social de los Conocimientos, Creatividad e Innovación
DENAREF	National Department of Plant Genetic Resources	Departamento Nacional de Recursos Fitogenéticos
ESPAC	Continuous Agricultural Land Area and Production Survey	Encuesta de Superficie y Producción Agrícola Continua
FAO	Food and Agriculture Organization of the United Nations	
FIASA	Agrobiodiversity, Seed, and Sustainable Agriculture Research Fund	Fondo de Investigación para la Agrobiodiversidad, Semillas y Agricultura Sustentable
FLAR	Latin American Fund for Irrigated Rice	Fondo Latinoamericano para Arroz de Riego
INIAP	National Institute for Agricultural Research	Instituto Nacional de Investigaciones Agropecuarias
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture	
KOPIA	Korea Partnership for Innovation of Agriculture	
LOASFAS	Organic Law on Agrobiodiversity, Seeds and Promotion of Sustainable Agriculture	Ley Orgánica de Agrobiodiversidad, Semillas y Fomento de la Agricultura Sustentable

Acronym	English	Spanish*
LORSA	Organic Law on the Food Sovereignty Regime	Ley Orgánica del Régimen de la Soberanía Alimentaria
MAG	Ministry of Agriculture and Livestock	Ministerio de Agricultura y Ganadería
NGO	Non-governmental organization	
PIATER	Technical Assistance and Rural Extension Innovation Project	Proyecto de Innovación de Asistencia Técnica y Extensión Rural
PNIPSA	National Project of Productive Incentives for the Agricultural Sector	Proyecto Nacional de Incentivos Productivos para el Sector Agrícola
SENADI	National Intellectual Property Service	Servicio Nacional de Derechos Intelectuales
UNORCAC	Union of Campesino and Indigenous Organizations of Cotacachi	Unión de Organizaciones Campesinas e Indígenas de Cotacachi
UPOV	International Union for the Protection of New Varieties of Plants	Unión Internacional para la Protección de las Obtenciones Vegetales
UTN	Technical University of the North	Universidad Técnica del Norte

*Given for acronyms based on the original Spanish name

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Translation and terminology

This report has been translated from the original Spanish *Sembrando la diversidad: Conociendo los sistemas de semillas utilizados por los agricultores en el Ecuador*. https://doi.org/10.21355/b267-n212.

The translation was produced with the help of artificial intelligence (Co-Pilot), and all content was carefully reviewed and confirmed by the first author. The aim was to remain faithful to the original text while preserving the cultural specificity and voice of key actors in the seed system. For this reason, the English version retains certain terms and expressions in Spanish or Kichwa when they carry specific cultural or contextual meaning. An appendix is included with the English, Spanish/Kichwa, and scientific names of the crops discussed in the report.

Notes on Terminology

1. Use of Spanish and Kichwa terms: Terms with cultural, agricultural, or place-based meaning are kept in Spanish or Kichwa. This includes some institutional roles—such as *piladora*—where a direct translation would not fully convey their function. Brief explanations are provided at first mention when needed.
2. Variety names and biological terms: Local and traditional variety names are retained in their original form; registered cultivars follow official nomenclature. Common names of pests and diseases used by farmers and technicians are also maintained, with clarifications provided where appropriate.
3. Institutions and laws: For entities listed in the acronym guide, the English name is given at first mention, followed by the acronym; the official Spanish name appears in the acronym list. Some organizations known primarily by their Spanish names remain in Spanish.
4. Quotations: Original phrasing from interviews is preserved to maintain participant voice, with explanations added only when necessary for clarity.

Executive summary

This report presents the results of the research phase of the project "Biodiversity for Opportunities, Livelihoods and Development" (BOLD), which aims to analyze the functioning of seed systems in Ecuador to identify ways to improve smallholder farmers' access to and sustainable use of crop and varietal diversity, as well as their seed security.

The study focuses on seed systems in two locations that represent contrasting contexts: the diversified maize system of Kichwa Indigenous communities in the canton of Cotacachi in the Sierra and the intensive, commercial rice system managed by small-scale farmers in the canton of Daule on the Coast. We use a conceptual framework that considers the contributions of both formal and informal actors to the functioning of the seed system and how they affect small-scale farmers' seed security. Qualitative methods were employed to examine the roles, activities, and performance of actors in three key seed system functions (variety development and management, seed production, and seed dissemination) and to assess farmers' seed security. The dataset includes focus group discussions with farmers in six communities in Cotacachi and four in Daule to characterize local seed systems and farmers' seed security situation, 31 key informant interviews to explore the functioning of the seed system, and workshops and document review.

Seed security: At the local level, the results of the focus groups show different realities between the two cantons, but also some parallels. In the Sierra, the Kichwa communities of Cotacachi manage a high diversity of crops and varieties within the *chacra* production system. Seed systems were analyzed for five key crops: maize, which is considered *la mamá de nuestra base alimenticia* (the mother of our food base) and has high cultural significance, as well as common bean, fava bean, pea and potato, which are valued both for their nutritional and income-generating roles. Farmers use several sources, all informal, to obtain seed. The main source is farmers' own seed produced at the household level, which is supplemented with seed obtained from social networks, fairs, and seed dissemination activities organized by UNORCAC, a grassroots organization, as well as from commercial actors such as small shops, markets, and traders. Farmers generally rely more on their own seed and nearby sources (from relatives and neighbours), which they consider to be both higher quality—assessed mainly in terms of the seed's adaptability to local conditions—and more readily available. However, they note some difficulties with the production and storage of their own seed, especially in the management of pests and diseases affecting maize and potato. Other sources such as local fairs, farmers from other communities, and commercial actors are considered less reliable and are generally used occasionally to try different varieties. However, there are cases in which farmers in Cotacachi primarily turn to these external sources, for example, when their own production is affected by diseases such as potato purple top, to obtain varieties that are more accepted in the market, or when it is not practical to allow the seed to dry in the field (as in the case of common bean in one community with a more commercial focus). Drawing on these different sources, farmers report that they do not experience challenges in accessing the seed they need. In terms of varietal diversity, farmers identified common names for 57 varieties of the key crops, including 39 that occur in one or more of the six communities (7 of which are improved varieties) and 18 that have been lost locally. Farmers evaluate varieties in terms of consumption characteristics, production, market value, and conservation status. Even if they notice that certain varieties have low market acceptance or are susceptible to pests and diseases or climatic conditions, they are generally satisfied with the varieties they have and express the desire to maintain and/or recover their own varieties. However, some also indicate an interest in trying new

varieties to expand their "collections" or because these have good marketability. That said, farmers also expressed concerns that new varieties may not adapt well to their local conditions.

On the Coast, farmers in Daule mainly produce rice for commercial purposes, although they also consume some of the harvest at household level and use the by-products as animal feed. Farmers also grow other crops in their homegardens or along the rice paddy bunds. Given that rice is the backbone of the local economy, the seed system analysis in Daule focused on this crop. Since the 1960s, rice cultivation has intensified with Green Revolution technologies, leading to the replacement of local rice varieties with improved varieties. Even so, the use of certified seed represents only 17% of the rice area sown at the national level, and informal seed sources predominate. However, few farmers in Daule produce their own seed, due to storage challenges. Instead, they mainly turn to local seed producers—farmers who produce and sell recycled seed—known locally as *productores de semilla artesanal*. Other informal sources are unofficial shops, which are not authorized by the Ministry of Agriculture and Livestock (MAG), and neighbours providing commercial rice grain (not intended for use as seed). Farmers purchase certified seed from seed company outlets, the CESA plant (a non-profit organization that works with farmer groups to produce certified seed), or through a Prefecture initiative that distributed seed in 2022. Farmers recognize that certified seed has the best quality, but access is limited by the cost, which they consider too high compared to the profitability of the crop. In contrast, seed from local seed producers is preferred as it is more affordable and generally considered to be good quality. However, farmers note that although some local seed producers manage their seed with care, others sell poor-quality seed mixed with other varieties or contaminated with pests and diseases. Similarly, some farmers mention that they are wary of certified seed sold by certain agro-dealers. Small-scale farmers in Daule sometimes experience seed availability problems when seed from recognized local seed producers is in short supply or unavailable at the desired time, forcing them to turn to less desirable sources. Economic constraints also force some farmers to borrow, exchange or barter "seed" from their neighbours, which is considered a last resort as it is commercial grain and not seed *per se*. In terms of varietal diversity, nine improved rice varieties were identified as being grown in the four communities. SFL-011 has been the most widely planted rice variety on the Coast for several years, mainly because of its market price, but it is little appreciated by farmers for home consumption and has certain agronomic drawbacks. Other varieties, generally cultivated only in small areas or by a few households, have agronomic and culinary advantages, but are less accepted by the *piladoras* (rice mills). In Daule, many farmers are dissatisfied with this situation and would like a variety that meets all their criteria.

Seed system functions: The analysis of seed system functions considers the contributions of actors at different levels and the influence of contextual factors relevant to understanding how to strengthen farmers' seed security. In terms of variety development and management, farmers have always played an important role through the diversity they grow in their fields and their practices of variety selection and adaptation, which generate new diversity in their localities. These activities are influenced by cultural and culinary values and practices, but also by markets that create both opportunities and constraints for the use of diversity. This is true in both commercial and traditional areas, as seen in Daule and Cotacachi. The most important *ex situ* collection in the country is maintained by the National Genebank of the National Department of Plant Genetic Resources (DENAREF) of INIAP (National Institute for Agricultural Research). DENAREF also collaborates with other entities to promote the conservation and use of agrobiodiversity, including the restitution of germplasm to communities. To facilitate this work, INIAP has promoted the establishment of Agrobiodiversity Bioknowledge Centres (CBDAs), managed by producer organizations, local governments or universities. We identified 11 CBDAs that have been established, but some of these have ceased to function. These actors, together with NGOs and international organizations, support the use of agrobiodiversity through seed fairs, *diálogos de saberes* (knowledge-sharing dialogues), alternative market channels and educational activities, among others. These strategies are recognized in the Organic Law on Agrobiodiversity, Seeds and Promotion of Sustainable Agriculture (LOASFAS) of 2017 and are

promoted at the national level by MAG's Subsecretariat of Family and Small-Scale Farming (AFC). Even so, efforts to promote the use of agrobiodiversity are generally focused on the Sierra and high biodiversity zones such as Cotacachi, with few initiatives in the commercial zones of the Coast such as Daule. Nonetheless, there is a seed savers' network, the Red de Guardianes de Semillas, that promotes seed exchange at the national level, covering 17 provinces in the four regions of the country.

In the formal system, INIAP has been a major player in the development of new varieties since the 1970s, having registered the vast majority of improved varieties of crops of importance to the Sierra, such as *maíz suave* (floury-type maize), potato and some legumes; these were mainly developed by INIAP's breeding programs. The institute has also developed almost half of the country's registered rice varieties, but private companies play a more important role for both rice and *maíz duro* (flint-type maize). Companies generally bring in materials from abroad; however, some companies such as Interoc and Agripac have established breeding programs for *maíz duro* and rice. Several universities also have breeding activities. For Sierra crops, breeding objectives have varied, including disease and climate stress resistance, improving yields, promoting agro-industrial uses and/or specific market niches, as well as contributing to the conservation of native varieties by enhancing certain traits to encourage wider use. INIAP has adopted participatory breeding approaches, and there are several examples where breeding has been linked to value chain development, through collaboration with producer associations, market actors and organizations such as the International Potato Centre (CIP). INIAP's breeding programs depend heavily on external funding to sustain their activities; in recent years, lack of financial and human resources has limited breeding work with crops such as common bean, fava bean and pea. In the case of rice, until the 2000s INIAP sought to generate varieties with higher productivity, shorter cycles and disease resistance, but later more attention has been paid to the quality demanded by the rice industry. However, it is the SFL-011 variety, registered by the company Agripac, which dominates the national market. Some initiatives are also seeking to develop varieties for other national or international niche markets. While breeding for highland crops has mainly used Ecuadorian germplasm, rice breeding has worked more with lines developed by the Latin American Fund for Irrigated Rice (FLAR).

In terms of seed production, Ecuadorian legislation recognizes two seed classes: *semilla campesina* (farmer-managed seed) and certified seed, which is subject to regulation by the State. A "mixed seed system", combining elements of both, has also emerged. At the national level, *semilla campesina* dominates, being used for 69% of the area cultivated with annual crops. In this study we identified two modes of *semilla campesina* production: the production of farmers' own seed, which they save from their harvest for the next planting cycle—a practice that predominates in Cotacachi; and the production of *semilla artesanal*, which is the most important source in Daule. Local seed producers are farmers who dedicate separate plots to produce seed for sale to other farmers; those who manage their seed well, implement various practices to maintain seed quality, using certified seed as starting material. We identified challenges with the quality of *semilla campesina* in both cantons, but farmers receive little specific technical support for this activity. Although the law guarantees the right of farmers to produce, exchange and sell their seed, improving the quality of *semilla campesina* itself is not a strategic objective of the State.

In contrast, certified seed production aims to ensure that the seed meets the quality standards defined in the LOASFAS and its implementing regulation, as well as in the specific technical standards for each crop. The varieties produced as certified seed must be registered in the National Cultivar Register. MAG controls the certification process through field inspections and laboratory analysis, issuing labels if the requirements are met. According to the LOASFAS, INIAP is authorized to produce the early generation seed categories for accredited seed producers, doing so mainly for varieties developed by the Institute, while private companies produce the early generation seed of their own varieties. Private companies dominate in the production of certified seed for commercial crops such as rice and *maíz duro* but have limited interest in other crops. As a result, producer associations and individuals play a more important role in seed

production for crops such as potato, *maíz suave,* and legumes; however, only small quantities of certified seed of these crops are produced. Challenges related to certified seed production include gaps in technical standards, difficulties in estimating demand for certified seed, and low varietal diversity. The latter is partly due to market dynamics that favour certain varieties such as SFL-011 in rice and Superchola in potato. In addition, the process to request early generation seed from INIAP is too lengthy and impractical for some actors. In response, INIAP has sought strategies to maintain its varieties in the market, for example, requesting authorization to produce certified seed or licensing private companies to produce early generation seed of their varieties. In the Sierra, another response to the lack of availability of certified seed has been the development of "mixed seed systems". In this approach, farmer associations have been supported by organizations such as INIAP and CIP to produce seed with internal quality control processes, carried out by members of the group, which are less demanding than certified seed, but which ensure a minimum quality. These initiatives are similar to the FAO's Quality Declared Seed system. The LOASFAS provides for the development of internal quality regulation processes by farmers' seed producers, but this has not yet been implemented. We did not identify any mixed system initiatives on the Coast, although some NGOs such as CESA work with farmers to produce certified seed.

Seed dissemination involves several actors who facilitate farmers' access to seed and related knowledge. Farmers, including local seed producers, disseminate *semilla campesina* through social networks, while seed producer groups sell mainly to members of their organizations, and sometimes to institutional actors. Various actors promote seed exchange through seed fairs and seed distribution initiatives, usually in the context of specific projects. The Red de Guardianes de Semillas uses social media and courier services to facilitate seed exchange among its members. Information on seeds and varieties is also transmitted through these different mechanisms, although this is affected by cultural and economic changes within communities. Certified seed is marketed in points of sale authorized by MAG such as seed company outlets, agro-dealers, and institutions such as INIAP and CESA. MAG carries out inspections at these points, but this is not enough to prevent the sale of counterfeit seed, which creates mistrust among farmers. The high cost of certified seed is another barrier to its use by farmers. Strategies that have been implemented to facilitate farmers' economic access to quality seed include subsidy programs, agricultural insurance and credit, and the promotion of bio-inputs and other agroecological practices to reduce production costs. Farmer seed production groups such as those of CESA, or mixed systems in the Sierra, also facilitate economic access by selling seed at a more affordable price. Since 2012, MAG's *Plan Semillas* has benefited at least 40% of rice producers with the delivery of "technology packages". However, our data suggest that many farmers stop using certified seed when the subsidy is withdrawn. Agricultural extension and technology transfer programs also play a role in disseminating information on seeds and varieties. Private companies disseminate information about their products through posters, fact sheets, field days and websites, mainly targeting medium and large farmers. INIAP works with farmer groups in participatory processes of validation and dissemination of new varieties, using the farmer field school approach. However, INIAP has limited presence on the ground, and thus tries to collaborate with local governments and MAG's Technical Assistance and Rural Extension Innovation Project (PIATER). PIATER is working to introduce farmer field schools as a central methodology in its work, but from the available data it is not clear to what extent the project covers seed-related issues.

Based on the interviews conducted, we identified two aspects of the governance system that affect the seed system across all functions: the coordination of diverse interests, as well as politically driven turnover and administrative challenges. In the first case, the legislative context in Ecuador has changed significantly since 2008, when a new Constitution was adopted, establishing food sovereignty as a strategic objective of the State. Reforms in the Seed Law expanded the legislative framework to cover not only certified seed, but also *semilla campesina*, agrobiodiversity and the promotion of sustainable agriculture. While this process represents an attempt to coordinate different interests within the country, the seed system landscape is still characterized by a diversity of perspectives

and visions. Another recurring theme is the impact of political influence on the functioning of the seed system, especially the frequent turnover in leadership and staffing within public institutions, which disrupts continuity in ongoing work. Additionally, the lack of investment and administrative challenges in public research affect the capacity of actors such as INIAP and the CBDAs associated with public institutions. In this context, the Agrobiodiversity, Seed, and Sustainable Agriculture Research Fund (FIASA), established by the LOASFAS, is seen as a welcome source of funding, with the potential to revitalize activities within the seed system.

Perspectives for improving seed security: Key informants and focus group participants made several suggestions for improving farmers' seed security. In terms of access to preferred varieties, farmers in Cotacachi expressed a desire to promote the conservation and use of their own varieties and customs. To this end, interviewees suggested further strengthening CBDAs, promoting seed fairs, and creating more market opportunities for agrobiodiversity products. In Daule, participants placed greater emphasis on the need to develop a new variety of rice that better meets their criteria than on conservation. However, the idea of supporting crop diversification along the paddy bunds (earthen embankments bordering the rice fields) was mentioned, as well as reviving "zoning" practices, where farmers would plant different rice varieties according to their specific conditions, and also rotate varieties from one cycle to the next. That said, participants also noted that the current market dynamics do not favour diversification. As a result, it was proposed to strengthen collaboration between the *piladoras* and other seed system actors and also ensure that the official prices established by the MAG are enforced.

With regard to seed quality and availability, farmers in both areas asked for support to improve their seed production. In Cotacachi, farmers request assistance in controlling pests and diseases that affect their potato and maize seed. In Daule there is interest to strengthen the production of *semilla artesanal* through approaches similar to the mixed seed systems promoted in the Sierra. To further increase the diversity, availability and quality of seed in the Sierra, several suggestions were made: expanding work with farmer seed producer groups, decentralizing INIAP 's early generation seed production for potato to make more varieties available, and securing resources so that INIAP can produce certified seed for minor crops that are not currently produced in the formal system.

In terms of seed dissemination and access, farmers in Cotacachi suggest continuing to promote seed exchange, with greater attention to the adaptability of the varieties disseminated. The CBDA of the Technical University of the North suggested establishing a storage and distribution centre to facilitate seed dissemination and exchange on a more permanent basis. On the Coast most of the suggestions focused on promoting the use of certified seed, with a variety of proposals to reduce the price of seed, improve the economic situation of rice farmers, and increase farmers' confidence in certified seed. Some stakeholders consider it important to make farmers more aware of the benefits of certified seed.

Regarding the role of the National Genebank within the seed system, the primary users are INIAP's breeding programs and farmers involved in germplasm restitution initiatives. Although DENAREF conserves valuable genetic resources, there are challenges in maintaining such an extensive collection, and in promoting broader use and distribution of germplasm. In this study, the seed system actors we interviewed offered several suggestions for improving the role of the National Genebank. These included improving operations, facilitating access to conserved materials, strengthening collaborations with different actors, and increasing outreach about the Genebank's activities.

Recommendations: Based on the information gathered, we propose strategic options to improve smallholder farmers' access to a diversity of good quality seed and to strengthen the National Genebank's role within the seed system.

Cecilia Cumba displays ears of the maize variety called Racu puca sara. Women in Cotacachi use different maize varieties to prepare a diversity of traditional dishes. For example, Racu puca sara, which means “thick red maize,” is used together with Yana sara (black maize) to make a thick, sweet beverage with a characteristic purple colour called colada morada. Photo: Luis Salazar/Crop Trust

1 INTRODUCTION

1.1 Background

The **Biodiversity for Opportunities, Livelihoods and Development** (BOLD) project is a ten-year project (2021–2030), funded by the Norwegian government and coordinated by the Crop Trust. The overall objective of the project is to strengthen food and nutrition security by supporting the conservation and use of crop diversity conserved in genebanks. The project has five components: 1) Develop National Genebank capacities; 2) Diversify the genetic base of seven crops with materials from wild relatives; 3) Strengthen linkages between national genebanks and other actors in the seed system; 4) Facilitate security duplication of germplasm collections of national, regional and international importance; and 5) Communicate the value of crop diversity and advocate for the necessary financial, legal, technical and institutional support at national and international levels. Ecuador is one of more than 50 countries involved in the project. More information on the BOLD project can be found on the project website: https://bold.croptrust.org/.

This report presents the results of a research phase carried out in Ecuador as part of the third component, "Genebanks and seed systems". Historically, the material conserved by genebanks has been used mainly by breeders to develop new varieties. However, there is growing evidence that other avenues can, and are being, used to facilitate farmers' access to diversity. Therefore, the objective of this component is to investigate existing and potential ways of linking genebanks with the seed systems used by farmers, and to support innovative efforts to improve access to crop diversity and seed security for smallholder farmers. To this end, during the period 2022–2023, the Norwegian University of Life Sciences (NMBU), in collaboration with national partners, carried out a study on seed systems in four countries with very different national contexts: Ecuador, Uganda, Tanzania and Bhutan. In Ecuador, the national partners are the National Institute for Agricultural Research (INIAP) and the Central Women's Committee of the Union of Campesino and Indigenous Organizations of Cotacachi (CCMU). The results of the study were discussed with key stakeholders at roundtables held in Cotacachi and Daule in August 2024. The study will serve as a basis for the design of pilot projects to be implemented in the period 2025–2030 to test different models for increasing access to crop diversity and improving seed security for smallholder farmers. Lessons learned from this component of the BOLD project will be disseminated through scientific publications, learning events and other communication strategies.

1.2 Objectives of the study

The overall objective of this study is to propose ways to strengthen linkages between genebanks and other actors within the seed system, to improve smallholder farmers' access to and sustainable use of diverse crops and varieties, as well as their seed security.

The study focuses on the seed systems of two regions of Ecuador: the Sierra and the Coast. In the Sierra, the research site is the canton of Cotacachi, Imbabura province, characterized by the diversified maize system of Kichwa Indigenous farmers. On the Coast, the study examines the intensive rice system managed by small-scale farmers in the canton of Daule, Guayas province. While these two sites do not encompass the full cultural, social and agroecological diversity of Ecuador, they serve as contrasting examples that enable the analysis of the contributions of both the informal and formal seed systems.

To achieve the general objective, we defined three specific objectives. First, the study aims to explore and characterize seed systems at the local level in Cotacachi and Daule, focusing on farmers' perspectives and needs related to their management and use of crop diversity, their production systems, seed sources, and seed security challenges.

This local-level analysis provides valuable insights to guide interventions that effectively address farmers' needs.

Second, the study examines the functioning of the seed system by mapping and assessing the roles, activities and performance of actors at local, regional and national levels that influence the maize and rice systems in Cotacachi and Daule. This includes examining institutional and other contextual factors that influence farmers' access to a diversity of crop species and varieties. Through this analysis, we identify the strengths, weaknesses and dynamics of seed governance as perceived by seed system actors. We focus on the crops and actors most relevant to Cotacachi and Daule, but perspectives and experiences from other locations in the Coast and Sierra regions are also incorporated.

The third and final objective is to identify options for improving smallholder farmers' seed security and strengthening the role of genebanks. This analysis is based on insights emerging from the above analyses, as well as perspectives shared by a range of different seed system actors.

The present report is organized as follows: First, we describe the study's approach and methodology, highlighting the study sites, conceptual framework, and methods for data collection and analysis. We then present the results characterizing the seed systems in the cantons of Cotacachi and Daule, followed by the analysis of seed system functioning. Finally, we summarize the perspectives of the focus group participants and key informants regarding key seed-related challenges and their recommendations for improving farmers' seed security and the role of the National Genebank.

Rice fields in Daule, the “Rice Capital” of Ecuador

2 APPROACH AND METHODOLOGY

2.1 Study sites

This study focuses on the diversified maize system in Cotacachi canton, Imbabura province, and the intensive and commercial rice system in Daule canton, Guayas province (Figure 1). These two cantons were selected to represent different contexts for analyzing the contributions of both the informal and formal seed systems.

Cotacachi

The territory of Cotacachi takes its name from the Cotacachi volcano, whose slopes are home to the canton's communities. It is located 80 km north of Quito, on the western plain of the Hoya del Imbabura. Part of the canton's territory belongs to the Cotacachi-Cayapas Ecological Reserve, and it is situated near the Cayambe-Coca National Park to the east and the Andean Chocó Biosphere Reserve to the west, making it an ecologically and bioculturally important corridor. To the north it borders the canton of Urcuquí and the province of Esmeraldas; to the south the canton of Otavalo and the province of Pichincha; to the east the canton of Antonio Ante; and to the west the provinces of Esmeraldas and Pichincha. It covers an area of 1,809 km^2, representing 33% of the total area of the province of Imbabura, making it the largest canton in the province.

In 2023, the territory of the indigenous communities of Cotacachi was designated by the Food and Agriculture Organization of the United Nations (FAO) as a Globally Important Agricultural Heritage System for the Andean *chacra* production system, an ancestral practice that sustains local livelihoods and food security. This designation recognizes the communities' efforts to conserve their rich agrobiodiversity, traditional knowledge and cultural practices related to agriculture; promote collective action through community organizations; and maintain the unique natural and cultural landscape that has emerged as a result.

According to data from the 2022 Ecuador Census, the population of Cotacachi consists of 53,001 inhabitants. About 60% live in rural areas; of these, 54% self-identify as mestizo, and 42% as indigenous of the Kichwa nationality. For the purposes of this study, we have focused on the indigenous communities located in the rural parishes of Quiroga and Imantag (Figure 1). In these areas, agriculture takes place at elevations of approximately 2,300 to 3,300 m above sea level. There is significant crop diversity cultivated both on farms and in homegardens (Rhoades, 2006; Skarbø, 2014). Agricultural holdings are small: 68.8% of households have between 1 and 5 hectares, and 31.2% have less than 1 hectare (III Agricultural Census, 2000).

The main crop is maize, typically grown in association with common bean and *sambo* (figleaf gourd), while potato and Andean tubers are also grown at higher elevations. The homegardens are rich micro-environments supporting a wide diversity of species used for food, medicine, ornamentation, fuel and fodder, as well as for their cultural (ceremonial) uses and to produce handicrafts and utensils. The seed system is largely informal and focuses mainly on native and traditional varieties.

Cotacachi is home to the Union of Campesino and Indigenous Organizations of Cotacachi (UNORCAC), a second-tier non-profit organization composed of 45 communities and various indigenous and mestizo campesino organizations. INIAP's National Genebank has collaborated for many years with UNORCAC and its Women's Central Committee (CCMU) on projects aimed at the conservation and sustainable use of agrobiodiversity (Tapia Bastidas & Carrera Rueda, 2013). These efforts have been institutionalized at the municipal level, with the approval in 2019 of the

Ordinance to Protect and Promote Agrobiodiversity and Associated Knowledge and Cultural Expressions in the Canton of Cotacachi.[1]

Daule

The canton of Daule is considered one of the oldest and most agriculturally productive cantons on the Coast, within the hydrographic basin of the Guayas River. It is located in the central part of the province of Guayas, bordered to the north by the canton of Santa Lucía, to the south by the canton of Guayaquil, to the east by the cantons of Urbina Jado, Samborondón and Guayaquil, and to the west by the cantons of Nobol and Lomas de Sargentillo. It covers an area of 535 km^2, with elevations between 8 and 25 m above sea level, and an average annual temperature of 26.8°C (Figure 1).

The rural population of Daule canton is mostly Montubio (62%) and mestizo (36%) (Ecuador Census, 2022). Rice is the main crop, covering approximately 70% of its agricultural land, although other crops are produced in smaller proportions, such as cultivated grass (for fodder), mango and *maíz duro*.[2] While some producers have landholdings larger than 20 hectares, most rice cultivation occurs on plots ranging from 1–10 hectares, with an average of less than 3 ha in the province of Guayas, according to a 2019 survey (Marín et al., 2021). Rice production is intensive, relying on modern varieties and a significant use of agrochemicals. Nationally, after *maíz duro*, rice is the second most important crop in terms of certified seed use, with 16.6% of the cultivated area, according to the Continuous Agricultural Area and Production Survey (ESPAC, 2022).

Rice has become a key component of Ecuador's economic development, and since the 2000s, Ecuador has achieved self-sufficiency in rice production. Gross national rice production reached 1.56 million tonnes on a harvested area of 343,022 hectares (ESPAC, 2022), with approximately 76% of this production coming from Guayas (76%). Daule is the canton with the highest production in the province (Alava Vera et al., 2018) and is sometimes referred to as the "Rice Capital" of Ecuador.

2.2 Conceptual framework

To improve farmers' access to crop diversity, it is essential to understand the seed systems used by farmers in both regions (de Boef et al., 2010). A seed system consists of the actors, activities and institutions involved in the maintenance of crop diversity, the development and selection of varieties, and the production and dissemination of seeds (Almekinders & Louwaars, 1999). While seed systems are often categorized as informal or formal, there are many linkages and interdependencies between the two, and farmers often obtain seed from both (Almekinders & Louwaars, 2002). To achieve a more holistic analysis, in recent years several studies have outlined the core "functions" of seed systems, identifying the essential activities present in any seed system. Focusing on seed system functions enables a better understanding of the contributions of different actors whether regulated by the State ("formal") or by community and social norms ("informal") (Christinck et al., 2018; Louafi et al., 2021; van Etten et al., 2017; Westengen et al., 2023). In this study we focus on three functions to analyze the contributions of different actors in seed systems:

1. Variety development and management: Includes activities related to the conservation and management of crop diversity and plant genetic resources, as well as breeding, selection and adaptation of varieties.

1 Original title in Spanish: *Ordenanza que protege y promueve la agrobiodiversidad, los conocimientos, saberes y manifestaciones culturales asociadas a ella del cantón Cotacachi*.

2 In Ecuador, *maíz duro* refers to flint-type varieties that have hard kernels. It is used to prepare some traditional foods (*choclo*, *locro de papas*), as well as for animal feed and in processed products. It is cultivated in various parts of the country, but on the Coast is mainly destined for industrial purposes.

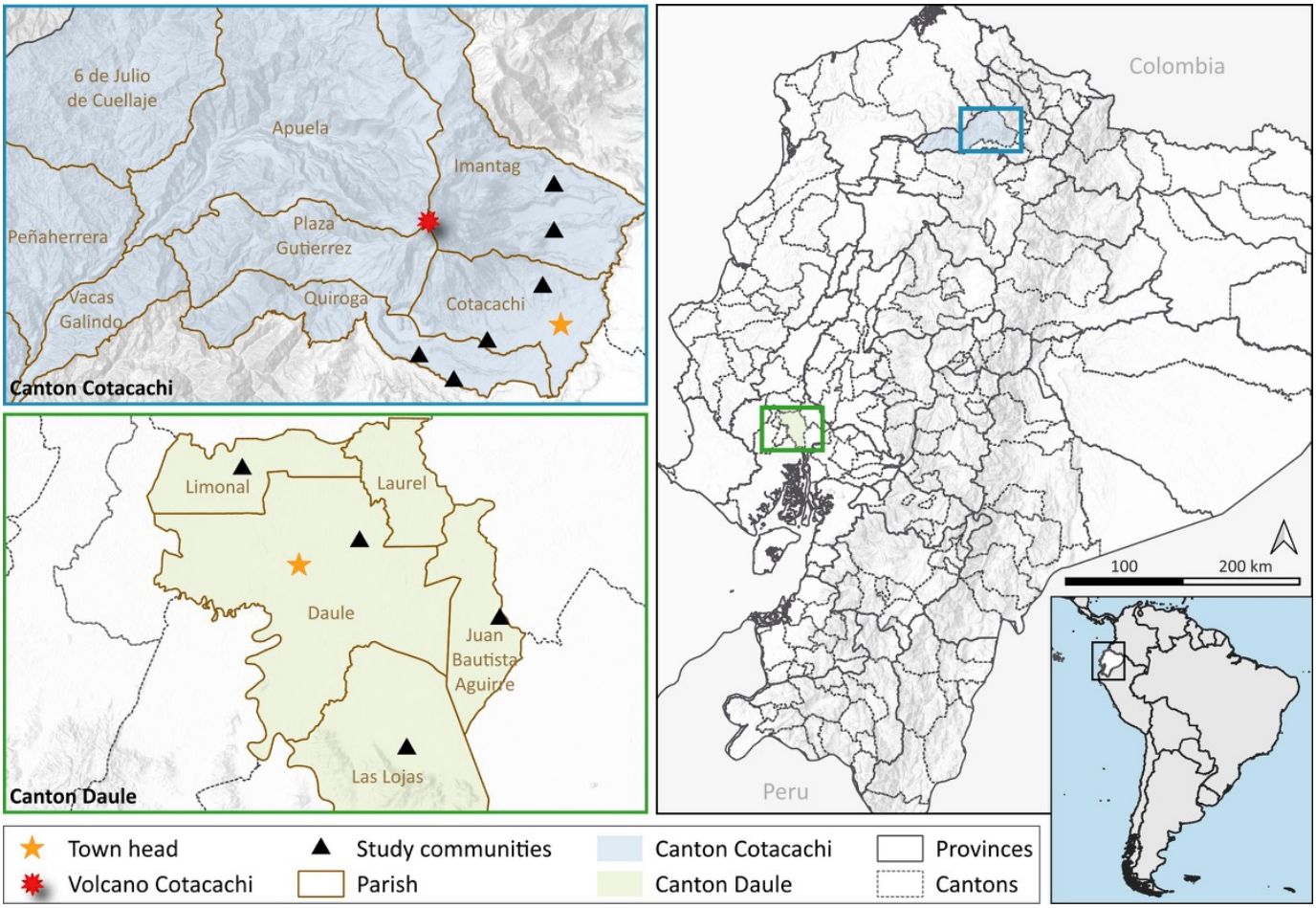

Figure 1. Geographical location of Cotacachi and Daule cantons and of the study sites in each canton.

2. Seed production: Covers the production of all categories of seed, both farm-saved seed and certified seed, as well as the processes for quality control and seed storage.

3. Seed dissemination: Includes all processes that make seed available to farmers, through different sources such as social networks, agro-dealers, seed delivery programs, markets, and other channels.

Our framework considers that a well-functioning seed system ensures seed security for all farmers, i.e. that "men and women within the household have sufficient access to adequate quantities of good quality seed and planting materials of preferred crop varieties at all times, in good and bad growing seasons" (FAO, 2016a). We use the seed security framework to assess how well seed systems function from the perspective of smallholder farmers. To do this, we consider the following four parameters, based on the FAO (2016) framework.[3]

1. Varietal suitability: Available crop varieties are adapted to farmers' conditions and respond to their preferences.

2. Seed availability: The quantity of seed available from all sources is sufficient to meet farmers' needs.

3. Access to seed: Farmers are able to obtain seeds through cash, loan, barter or gift. This also includes having adequate access to information about the seed and where it can be obtained.

3 FAO's seed security framework also includes resilience, i.e. the ability of farmers to maintain or increase their level of seed security after a shock or series of shocks and/or prolonged adverse hardship.

4. Seed quality: The quality of seed meets farmers' expectations. This may include parameters such as germination rate, physical purity, moisture content, phytosanitary condition, and genetic or varietal purity. However, farmers may have their own criteria for assessing quality.

It is also important to recognize that seed systems can be disrupted both by acute stresses such as conflicts and natural disasters, as well as by chronic problems such as social inequalities, inefficiencies, lack of coordination among actors, and inappropriate policies (Bentley et al., 2018; Madin et al., 2022; McGuire & Sperling, 2016; Mulesa et al., 2021). Seed systems, and by extension farmers' seed security, are therefore influenced by the broader context in which they operate. In this sense, seed systems can be understood as embedded in the wider food system, and their functioning is influenced by a range of socio-cultural, economic, political, institutional, biophysical, technological, and infrastructural factors (HLPE, 2020; Mausch et al., 2021).

Based on the above, our conceptual framework highlights the connections between the roles and activities of various actors, the functioning of the seed system and how it is influenced by the governance structures and broader food system drivers, and, ultimately, the level of seed security experienced by farmers (Figure 2).

2.3 Methods

Data collection

In this study we mainly use qualitative data to characterize seed systems at the local, regional and national levels. The data were collected through workshops and interviews with different actors involved in the seed system, and through focus group discussions with farmers in the cantons of Cotacachi and Daule. In addition, we reviewed published and unpublished documents, such as scientific literature, reports, statistics, national laws and regulations, registers and other data provided by key informants.
In November 2022, launch workshops were organized in the cantons of Cotacachi and Daule to introduce the study, discuss the overall goals and objectives of the project and to foster valuable discussion on seed systems. A total of 69 people attended the two workshops, including farmers from each of the two study areas, as well as representatives of non-profit organizations, plant breeding programs, genebanks, universities, seed companies, and various agencies

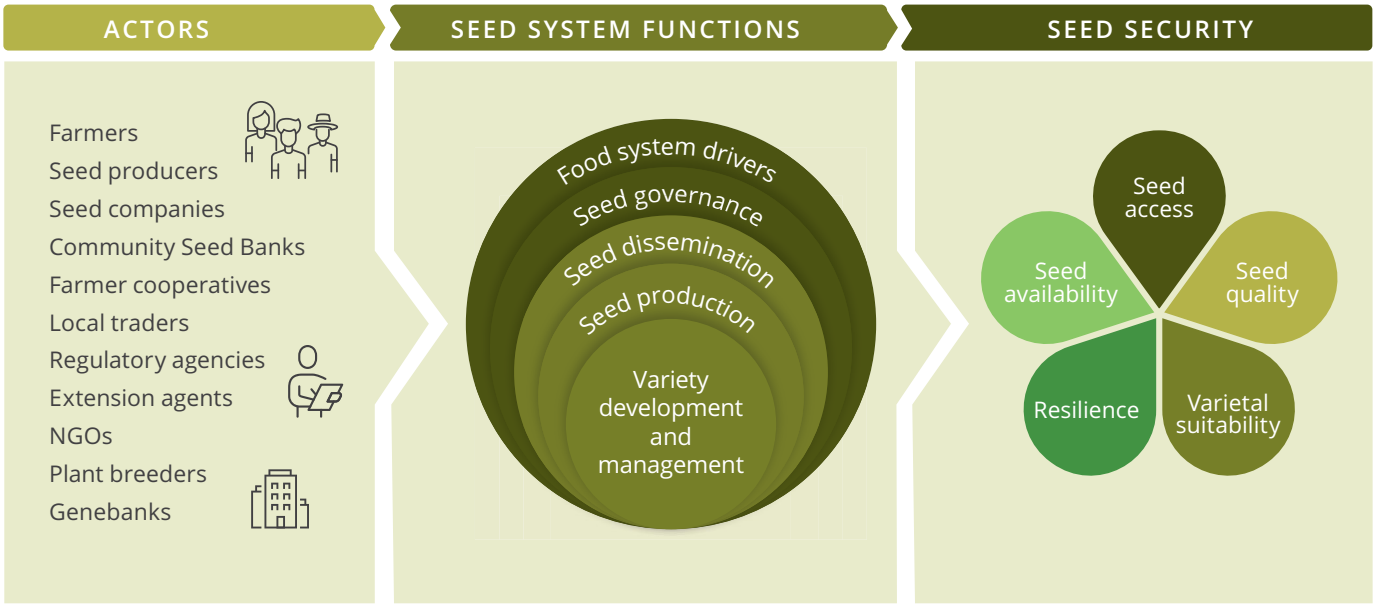

Figure 2. The conceptual framework used to analyze the contribution of seed system actors to the functions of the seed system, and the resulting outcomes in terms of farmers' seed security.

of the Ministry of Agriculture and Livestock (MAG). In each workshop there were presentations on the BOLD project, and different activities related to seed in the area. A participatory "cross-linkage" exercise was then carried out to analyze the interactions between the main actors in the local seed system, following Chevalier & Buckles' (2019, 2021) systems analysis method. The workshops provided an overview of the functioning of the seed system in each locality and supported the subsequent planning of the research.

Data collection through key informant interviews and focus group discussions was conducted between February and July 2023. As described above, the tools were based on Westengen et al.'s (2023) seed system functions and have been incorporated into a toolkit developed by NMBU in collaboration with partners in Bhutan, Ecuador, Tanzania and Uganda (NMBU Seed System Lab, 2023). These tools are largely based on existing methods, adapted for the purposes of the present study. This includes methods for seed security assessment (Seed System, 2022), four-cell analysis of crop diversity (Mulugo et al., 2021; Sthapit et al., 2012), and seed systems analysis (Subedi et al., 2013; TASAI, 2022). Before starting the data collection, the tools were pre-tested and adjusted as necessary. The research was conducted in accordance with the NMBU research ethics guidelines (NMBU, 2015) and the Norwegian standards for research ethics in the social sciences, humanities, law, and theology (Etikkom, 2014).

The focus groups served to characterize the seed system at the local level. Focus groups were conducted in a total of 10 communities, six in Cotacachi and four in Daule. The procedures for selecting communities and forming the groups are described in more detail in Chapter 3. Topics discussed in the focus groups included: the crops considered most important, changes and challenges in crop production, challenges in seed production, actors involved in the seed system, the seed sources used, and an assessment of the quality, availability and access of each source as well as varietal suitability. The analysis of seed sources and varietal suitability centred on the key crops identified by each focus group in the "most important crops" exercise. This resulted in the analysis of maize, common bean, pea, fava bean and potato in Cotacachi, and rice in Daule. It should be noted that, although the initial plan was to conduct separate focus groups for men and women in each community, this was only achieved in one community in Cotacachi. The composition of the groups largely reflects the gender roles in agricultural activities within each community, with some groups dominated by women and others by men. This limited the gender analysis that could be obtained from the data, especially in Daule where women's participation was low (see Chapter 3).

Key informant interviews were used to examine the functioning of the seed system. The interviews explored the roles and activities of actors within each function of the seed system (Figure 2), their strengths and weaknesses, their coordination with other actors, and the influence of contextual factors such as governance, markets, and cultural and social dimensions. Informants also shared their perspectives on seed system development and the role of the National Genebank. A total of 31 key informant interviews were conducted (Table 1). In some interviews, more than one person participated, for a total of 38 people (of which 37% were women). The actors were purposively selected for their roles in the seed system, based on information gathered in the launch workshops, during the focus group discussions and the research team's expertise. The selection also prioritized actors working with the key crops analyzed in the focus groups. Approximately 22 of the actors operate at the national or regional scale, while five focus more on the areas around Cotacachi and four on the Daule area. In some cases, it was not possible to obtain interviews with certain actors, especially from the private sector.

In August 2024, roundtable workshops were held in each canton to present the main research findings to key seed system actors. The purpose was to gather feedback on the study and discuss strategies to strengthen the seed systems. A total of 86 people attended in Cotacachi and 30 attended in Daule.[4] Participants were provided with a draft of the present report for their review and comments, which were used to revise and finalize the document.

Table 1. Summary of key informant interviews conducted on the functioning of the seed system

Actor category	No. of internviews			
	Cotacachi	Daule	Regional/ national actors	Total
Local seed producers and seed savers	2	2		**4**
Producer associations and non-profit organizations	1	1	3	**5**
Private agro-input companies	1		2	**3**
Piladoras (rice mills)		1		**1**
Agrobiodiversity Bioknowledge Centres (CBDAs)	1			**1**
Genebanks			2	**2**
INIAP (plant breeding, technology transfer, and seed production programs)			7	**7**
National rural extension and farmer support programs			3	**3**
Entities responsible for seed policy and regulation			5	**5**
Total	**5**	**4**	**22**	**31**

Data analysis

Reports summarizing the analysis and discussions from the focus group discussions were prepared using the recordings and notes taken during the sessions. Full transcripts were also produced for the key informant interviews. These documents were then organized using qualitative analysis software (MAXQDA version 2022).

Qualitative data from both the focus groups and key informant interviews were coded according to major themes derived from the conceptual framework as well as additional themes that emerged during the analysis. Narrative summaries were then prepared for each theme. These summaries were organized in a table to facilitate comparison of activities, roles and perspectives among the different actors.

The focus group discussions also included several structured exercises to analyze crop diversity, seed sources, and varieties of key crops. Data from these exercises were compiled in Excel matrices, and the frequency of the different responses was calculated across the focus groups in each canton.

Secondary data from various sources were used to triangulate and deepen the primary data collected.

Research team

The research team consisted of the NMBU, INIAP and CCMU. As INIAP and CCMU are also actors in the seed system, the work was organized as follows, according to each partner's expertise.

NMBU was responsible for the scientific coordination of the research and led the development of the methodology and the data analysis. INIAP provided technical coordination for the activities in Ecuador and assisted in identifying key actors within governmental entities and the formal seed system. CCMU supported the administrative coordination of the project, including managing the funds, hiring field technicians, and coordinating activities in Cotacachi.

4 In Cotacachi separate meetings were held for producers from the communities involved in the study and for the other institutional actors. This led to a higher number of participants in Cotacachi.

A field technician was hired in each canton (Cotacachi and Daule), along with a research assistant to support data analysis. The field technicians were local experts who had experience working with farmers in their respective cantons and were able to gain the trust of the local communities. They were responsible for the logistics in the field, organized the launch workshops, facilitated the focus group discussions with the help of an assistant, and compiled reports of the results from the focus group discussions. They also conducted some key informant interviews at the local level, but most of the interviews were conducted by an NMBU researcher and the research assistant. In addition to transcribing the interviews, the data analysis technician was responsible for the quality assurance of the focus group reports and assisted in the process of coding and analyzing the collected information.

Common bean diversity from Imbabura province, Ecuador. Photo: Luis Salazar/Crop Trust

3 SEED SECURITY: THE VIEW FROM THE GROUND

Here we present the results of the focus groups that give us an insight into the reality of the farmers and the functioning of the seed system at the local level. See Appendix 1 for a list of common and scientific names of the crops mentioned in this chapter.

3.1 The Sierra: the diversified maize system in Cotacachi

The analysis of the local seed system in Cotacachi was based on information collected from focus groups in six communities. The communities were purposively chosen to represent different agroecological and economic conditions, which could affect agricultural production and the seed system (Table 2). In terms of agroecology, all communities have maize as their main crop, but vary in elevation, with Peribuela and Morlán being the lowest, and San Nicolás the highest. The communities also vary in terms of the commercial orientation of agricultural production, which is largely influenced by plot size and access to irrigation. Families with smaller landholdings tend to produce mainly for consumption and sell surpluses to neighbours or family, while those with more land sell agricultural products at fairs and markets further away. In Peribuela, families have larger farms and access to irrigation, which allows them to produce maize and common beans for commercial purposes. Intermediaries purchase the produce directly at the farm-gate and resell it on urban markets. Some families have also established greenhouses to produce vegetables for the market. In Peribuela, men are more actively involved in agricultural production in contrast to the other communities with lower commercial orientation—particularly San Pedro and Morochos—where women take on most agricultural work while men engage in off-farm employment outside the community.

Table 2. Characteristics of target communities and focus group participants in Cotacachi

Characteristics*	Peribuela	Morlán		San Pedro	Cumbas Conde	Morochos	San Nicolás
Elevation of agricultural areas (m.a.s.l.)	2,434-2,896	2,502-2,951		2,667-3,107	2,646-2,862	2,681-2,854	2,862-3,065
Landholdings (ha)	5-6	0.2-2		<0.1-1	1-5	<0.1-4	2-6
Access to irrigation	Yes	Yes, in lower parts		No	No	No	No
Commercial orientation of production	High	Medium		Low	Medium	Low	Medium
Focus group participants							
Women	1	17	1	10	9	7	8
Men	5	1	6	0	2	3	2
Total	6	18	7	10	11	10	10

**Information collected from Google Earth satellite imagery (elevation), focus group participants (landholdings), and observations of the research team with long experience in the region (irrigation, commercial orientation). For elevation we give the lowest and highest point within the crop production areas (excluding the páramo, a type of high-altitude grass and shrubland).*

The focus groups were organized in coordination with the *cabildo* (community council) in each site, who invited men and women to participate. We tried to organize separate focus groups for men and women, but this was only achieved in the community of Morlán. The other groups were mostly women, except for Peribuela where more men participated (Table 2).

The focus groups were conducted between February and July 2023. Each group participated in two to three sessions, all held in Kichwa and facilitated by two moderators. In total, 72 people took part, 74% of whom were women. Age ranged from 17 to 89, with an average of 48 years. Just over half had primary (26%) or secondary (28%) education; one person reported technical training while the remaining 43% had no formal schooling.

In Peribuela, individual interviews were also conducted to better understand the community's more commercial context, and to validate information from the focus group discussions regarding seed sources, and related aspects such as quality, availability, and transaction types. The survey was conducted over two days, during which a total of 23 farmers engaged in maize or common bean production were interviewed. They were chosen purposively to ensure coverage of all sectors of the community. Age ranged from 26 to 75, with an average of 48 years, and 35% were women.

Crop diversity

A great diversity of crops is grown in Cotacachi. In the focus groups, participants worked to identify the ten crops considered most important for families in their community and then ranked them by importance. Based on this discussion, up to three key crops were selected in each community, which formed the basis for the seed security analysis presented later in this report. During this process, participants also discussed the value of different crops for men and women, as well as the factors that have driven changes in crop use and importance over time.

Across the seven focus groups (in six communities), participants identified a total of 25 "important" crops (Table 3). Maize was consistently ranked as the most important crop, followed by common bean. These two crops were therefore selected as key crops and analyzed in all focus groups. In one community, participants even referred to maize as *la mamá de nuestra base alimenticia* (the mother of our food base), emphasizing that its use and importance come from its role in preparing a wide variety of foods that are central to their culture. Common bean is similarly essential for household consumption and is often intercropped with maize. As noted in several communities, part of its production is also sold. Other reasons for the importance of these two crops include their use as animal feed, in ceremonial rituals and ancestral medicine (for example, maize to cure *espanto* and bean leaves for fever), and in small-scale industrial uses (for instance, one bean variety used in soap making).

The other crops selected as key crops were fava bean, potato, and pea. Fava bean was chosen in two communities; as one focus group explained, it is valued for its adaptation to cold climates, its use in food—particularly for preparing different types of *harinas*[5]—and, to a lesser extent, for grain sales. Potato was also selected in two communities. It is a dietary staple, and surplus harvests may be sold at local *ferias* (community-run farmers' markets); one group mentioned that potato leaves are used as fodder. Pea was selected in one community due to its high nutritional value, its marketability, and its short growing cycle.

In all groups, participants also mentioned many other crops grown at smaller scales, and some gender differences emerged in these discussions (Table 3). Groups composed mainly of men (Peribuela and Morlán) tended to name crops with higher market value, such as tomato, bell pepper, and cucumber—often grown in greenhouses—as well as fruits like Andean blackberry (*mora*) and goldenberry (*uvilla*).

5 *Harinas* refers to a range of toasted and milled flours prepared from maize, pulses and other crops, used in diverse household food preparations in the northern Ecuadorian Andes.

Table 3. Important crops identified in Cotacachi.

Cultivation	Frequency*	Importance ranking**										No. of groups that selected the key crop
		1	2	3	4	5	6	7	8	9	10	
Maize	7	7										7
Common bean	7		6	1								7
Fava bean	7			2	3	1			1			2
Pea	5			2	1	1	1					1
Wheat	4					1	2			1		
Barley	4						1	2	1			
Potato	3		1	1							1	2
Carrot	3						1	1			1	
Melloco	3					1		1	1			
Oca	3					1				2		
Chocho	3				2			1				
Quinoa	3					1	1		1			
Sambo	2								1	1		
Chickpea	2						1		1			
Mashua	2										2	
Zapallo	1							1				
Sweet potato	1									1		
Lemon	1										1	
Tomato	1			1								
Bell pepper	1				1							
Cucumber	1					1						
Sweet granadilla	1							1				
Andean Blackberry	1								1			
Goldenberry	1									1		
Arracacha	1										1	

The crops in boldface are those most marketed within the canton of Cotacachi. Red-bordered cells indicate crops that were mentioned only by groups composed mainly of women, while blue-bordered cells were mentioned only by groups dominated by men.

*Frequency indicates the number of focus groups that mentioned the crop as one of the 10 most important crops in their community.

** Importance ranking indicates how groups ranked the crop among the ten most important in their community, where 1 is most important and 10 is least important. The number of focus groups that gave the rank is indicated in each cell.

In contrast, groups composed mainly of women mentioned a variety of Andean crops, including those with higher market value—such as potato, carrot, quinoa, and *chocho*—and others that are less frequently sold, such as *oca*, *melloco*, *mashua*, *sambo*, and *zapallo*.

All focus groups agreed that men tend to prioritize more commercial and profitable crops, while women are more concerned with family nutrition and maintaining crop diversity. For example, in Morlán, women explained that they value a diversity of crops—such as maize, common bean, potato, pea, fava bean, quinoa, barley, wheat, various vegetables, and medicinal plants—because they know their nutritional properties, use them to feed their families, and rely on them to support health. They allocate production both for household consumption and sale, and they maximize space by intercropping to maintain diversity. Men, by contrast, viewed maize, common bean, and *morocho* (a white/pearly maize used for beverages and porridges) as the most important crops for consumption and sale, noting that these are the family's main source of income. In another group, participants remarked that men do not like to diversify because "they say it is a waste of time," preferring instead to plant larger areas of maize, common bean, and fava bean for the market. In San Pedro, where many men work outside the community in construction, participants noted that men do not consider agriculture profitable and only help women with certain tasks.

Drivers of change in crop cultivation

Over the past ten years, several factors have driven changes in crop cultivation, including economic motivations, shifts in dietary habits, and changing climatic and soil conditions. Economic motivations appear to be a particularly significant factor: they have led both to the introduction or expansion of some more profitable crops, as well as the reduction or abandonment of others with limited market demand. Crops that have been introduced or expanded include mainly vegetables and fruits such as tomato, cucumber, broccoli, Swiss chard, and goldenberry (*uvilla*). The case of goldenberry is noteworthy, as it was promoted for a period by a company exporting dehydrated fruit; they provided plants and agrochemicals along with training, in exchange for purchasing farmers' production. In some of the higher-altitude communities, the cultivation of traditional crops with better profitability—such as quinoa, *chocho* (Andean lupin), and pea—has increased, as has the cultivation of specific varieties such as the bean Canario.

Changes in dietary habits, especially among younger people who no longer consume certain products, have led to reductions in cultivated area or even the abandonment of some crops. The crops most affected have been traditional ones (e.g., *miso*, *sambo*, *zapallo*) and certain native varieties (e.g., of lentil and chickpea). This trend also affects major crops such as maize, where native varieties—for example, *Maíz negro*, *Canguil*, *Iritíco*, among others—have been replaced by varieties that are more commonly consumed, especially yellow maize.

Changes in climatic and soil conditions, susceptibility to pests and diseases, and agronomic factors such as long crop cycles and increased labor requirements are additional reasons cited for the abandonment or reduction in production of certain crops. These factors often interact. For example, in Morochos, farmers explain that rye, *miso*, and *zapallo* are no longer cultivated due to a lack of sheep and cattle manure, limited rainfall, and reduced consumption among younger generations.

Challenges in crop production

The crop production challenges faced by farmers in the communities of Cotacachi relate to a variety of factors, primarily climatic conditions and pests and diseases. Economic factors and issues related to crop management were also mentioned.

Across all communities, people spoke about the impact of abrupt climatic changes, which have resulted in increasingly extreme conditions such as droughts, frosts, heavy rainfall, and strong winds. These changes are closely linked to the growing susceptibility of crops to pests and diseases, among which participants mentioned *lancha* (late blight) in common bean, *roya* (rust) in maize, *la mariposa* (potato tuber moth), *gusano blanco* (white grubs), among others. These problems make chemical control necessary for certain crops, as is the case for potato. In one focus group, even birds and rats were mentioned as crop pests.

In the two focus groups composed mostly of men, economic challenges were also highlighted. In Peribuela, farmers are affected by high production costs while sale prices are sometimes low. The men's group in Morlán similarly emphasized production costs and the instability of sale prices, which they associate with intermediaries who do not pay fair prices,[6] as well as the absence of policies that support farmers. They also expressed the need for a space to market their products where they are fairly valued. Although the *La Pacha Mama nos alimenta* Agroecological Fair is intended to serve this purpose, it is not sufficient to meet demand.

Other factors were mentioned as specific cases in some groups. In the women's group in Morlán, participants spoke about the loss of favourable soil conditions caused by the lack of animal manure. They explained that they no longer raise animals because they lack space or because animals are often stolen. This makes the use of agrochemicals necessary, especially for those with larger plots, which they see as a problem not only due to the additional cost but also because they say it affects human and soil health. In the same community, they believe irrigation needs to be improved technologically, as they have lost crops due to lack of water.

All the issues mentioned above align with the focus groups' evaluation of the harvest in the last three seasons of their key crops. "Good" seasons depend largely on favourable climatic conditions (e.g., sufficient sunshine and rainfall, especially considering that most communities do not have irrigation water) and on the presence of pests and diseases, since these can limit production. In this regard, potato tends to be the most affected by phytosanitary problems; focus groups mentioned problems with *la mariposa* (potato tuber moth), which affected recent seasons. It is also worth noting that both communities are only just recovering from the *punta morada* (potato purple top) epidemic, which affected many parts of the country four to five years ago. Participants also spoke about the importance of planning agricultural activities in accordance with the lunar calendar to ensure good production.

In Peribuela, economic factors are decisive in evaluating a season's harvest: farmers consider a season to be "good" when sale prices are favourable. They explained that external factors have less influence because they produce for the market and take care to manage their crops well, for example, by applying the necessary products to control pests and diseases. In addition, they have access to irrigation, which minimizes the effects of climatic conditions. Even so, they mentioned a season of common bean that was considered "average" because there was excessive rainfall, which caused the grain to "burn."

Challenges in seed production

The challenges described above have a direct impact on seed production, since almost all farmers set aside a portion of their harvest as seed for the next planting. With regard to seed storage, farmers report having no major problems with common bean, fava bean, or pea, because the cold climate often favours conservation and these crops are not usually attacked by pests or diseases. However, in Morlán, people prefer not to store seed for too long.

In contrast, there are notable problems with the storage of maize and potato seed. In the case of maize, all groups—except San Nicolás—mentioned that the seed is attacked by a pest known locally as *redondilla* (maize weevil). As a result, they have chosen to store seed in containers with aluminum phosphide tablets (commercial name: Gastoxin), and to keep it stored for as little time as possible. They also use some ancestral practices such as *guayungas*, which consist of hanging maize ears inside the house with their husks still on, or storing seed in the attic of the house (*soberado*) with eucalyptus leaves. Although the cold climate in San Nicolás allows maize to be stored more effectively, farmers experience problems storing potato seed because it is attacked by *la mariposa* (potato tuber moth) and the tubers rot. For this reason, they do not produce potato seed themselves; instead, they

6 *Refers to intermediaries operating in the Wholesale Market of Ibarra*

primarily use the tubers for consumption, sell any surplus in the markets, and keep a small amount to plant immediately. As we will see below, the other community that analyzed potato (Morlán) has completely stopped using their own seed.

Seed security

In each focus group, participants identified the seed sources used in the community for each key crop. We then facilitated exercises to analyze the quality, availability and accessibility of these sources, as well as satisfaction with the varieties being used. For this exercise, seed sources used in the last three years were considered, to capture less frequently used seed sources, given that farmers' own seed is the primary source. In the case of Peribuela, the survey conducted with individual farmers focused on seed sources used in the last cycle. Below, we discuss farmers' overall assessment of their seed sources (considering all key crops), followed by an analysis of varietal diversity and suitability by key crop.

Seed sources used and their quality, availability and accessibility

The main seed sources identified in the focus groups—as well as ratings of their importance, quality, availability and the transactions used to access them—are summarized in Table 4.

In general, the sources can be grouped according to the main actors involved:

1. The household: Farmers' own seed, which they save from the harvest and store for use as seed.
2. Social networks: Social relationships through which seed is obtained from other farmers, including family members, neighbours within the same community, and farmers in other communities.
3. Grassroots organizations: Local fairs and seed dissemination activities facilitated by UNORCAC and its partners.
4. Commercial actors: Shops, markets, the "potato truck" (a mobile vendor who travels between communities selling ware potatoes), and *haciendas* (large estates) where the leftover grains are gleaned after the harvest (a practice called *chukchina*).

Of all these, the most widely used source is farmers' own seed, which was mentioned in every community and represents the principal source, reaching 70–100% of the seed used for almost all crops. Farmers consider their own seed to be of excellent quality, mentioning that it "guarantees production" because it is adapted to their conditions and germinates well. Several also note that their own seed does not require any chemical inputs. In general, farmers view their own seed as always available, since they save it from one harvest to the next. However, there can sometimes be challenges with availability. For example, the groups that analyzed potatoes (San Nicolás) and peas (San Pedro) note that sometimes they have only small quantities available; additionally, the women's group in Morlán mentioned that their maize seed stores can be depleted if used for household consumption, or due to storage losses caused by *polilla* (Angoumois grain moth).

According to the farmers, the other sources are used mainly to supplement their own seed when they do not have enough for planting, or to obtain and test other varieties. For crops such as maize and common beans, if additional seed is needed, farmers tend to approach their relatives and neighbours within the same community. Depending on the crop, these sources reach up to 8–15% of the seed used. Focus group participants expressed confidence in these sources because their relatives and neighbours, like themselves, save seed for the next planting and the quality is similar to own, because it is already adapted to local conditions and performs well. As with their own seed, these sources are considered to be always available. As one group explained, family members are the most reliable option for securing seed; then, if they still need more, they turn to their closest neighbour. However, another group noted that maize seed obtained from neighbours is only "sometimes available," as it is not always guaranteed that they will have enough, since they also use it for their own crops.

Table 4. Seed sources and their importance, quality, availability and transactions used in Cotacachi. Based on data gathered from focus groups and from the farmer survey in Peribuela.

Seed source	Description	No. of communities[1]	Importance[2,3]					Quality[3]	Availability[3]	Transactions[3]
			Maize	Common bean	Fava bean	Potato	Pea			
Own	Seed saved by farmers from the previous harvest	6	70–100% (6)	90–100% (5), 23% (1)	80–100% (2)	85% (1)	20% (1)	Excellent (16)	Always (14) Sometimes (2)	n/a
Family	Seed obtained from relatives	5	4–10% (4)	5–10% (3)				Excellent (7)	Always (7)	Gift (6), barter (4), exchange (3), cash (3) USD 1–1.50/lb, loan (2)
Community	Seed obtained in the same community, from neighbours or other persons who are not relatives	4	3–9% (3)	<1–8% (3)		15% (1)		Excellent (7)	Always (4+) Sometimes (2+)	Cash (7): USD 0.15/lb (potato), USD 1–1.50/lb (maize, common bean). Also exchange (3), gift (3), loan (2), barter (2)
Other communities	Seed obtained from farmers in other communities	4	1–17% (2)	2–27% (2)	2–8% (2)		1% (1) *	Good (4) Excellent (3)	Always (3+) Sometimes (3+)	Cash (5): USD 1–1.50/lb Gift (1)
Fairs	Seed obtained at the weekly *La Pacha Mama nos alimenta* Agroecological Fair or at the annual *Muyu Raymi* Seed Fair	5	<1–10% (4)	<1% (1)	10% (1)	3% (1)*	5% (1)	Acceptable (3) Good (3) Excellent (2)	Sometimes (6) Always (1) Rarely (1)	Cash (6): USD 0.15/lb (potato), USD 1–1.50/lb (other crops) Exchange (2)
UNORCAC	Seed distributed as part of projects	1		<1% (1)				Good (1)	Rarely (1)	Gift (1)
Traders	Seed obtained from small shops, markets, the potato truck (mobile vendor selling ware potatoes)	3	9% (1)	41%, <1% (1)*		90% (1)*, 7% (1)*	70% (1)*	Good (3+) Excellent (2+)	Always (4+) Sometimes (1+)	Cash (6): USD 0.15/lb (potato); USD 1–1.50/lb (other crops)
Chukchina	Seed collected after harvests on *haciendas* (large estates)	1					4% (1)*	Excellent (1)	Sometimes (1)	Barter (1): part of the payment for work carried out on the *haciendas*

[1]Number of communities where the source was mentioned for one or more crops.

[2]Importance is based on an estimate of the % of seed obtained by the source.

[3]The number of ratings made across all focus groups are indicated in parentheses (e.g. for importance, quality, availability and transaction type). For Peribuela, the data is based on the survey; a "+" is indicated when only part of the respondents in Peribuela gave the rating.

*The varieties obtained from these sources are considered "improved" or distinct from the local/native varieties.

Generally, seed sources outside their own community—whether from farmers, fairs, or commercial actors—are considered less reliable, both in terms of quality and availability. Many mentioned that they prefer to keep their own seed because they distrust seed from other places; when they do bring in seed from outside, it is only in small quantities, to test whether it adapts and produces well (Table 4). In Morlán, the women explained that it is important to verify where the seed comes from to increase chances that it will germinate in their fields. Seed obtained from farmers in other communities was generally rated as being of lower quality than that from their community ("good" rather than "excellent") (Table 4), mainly because they feel that it does not adapt well to their local conditions: sometimes it does not germinate well, the plants do not grow properly, or in other cases it requires the application of chemical inputs. However, in one community farmers considered that the fava bean seed they had purchased from other communities to be of "excellent" quality, because it had better production characteristics than their own varieties, and they are now saving it.

Local fairs are another source that farmers use to acquire new varieties from other producers. Apart from own seed, it is the only source mentioned for all the crops analyzed (Table 4). There are two types of fairs in Cotacachi, both organized by UNORCAC (in particular by its Women's Central Committee, CCMU). The first is the *Muyu Raymi* Seed Fair, which takes place every August before the maize planting season, where local farmers display, sell and exchange a wide variety of seeds of different crops. The second is the *La Pacha Mama nos alimenta* Agroecological Fair, which takes place every week at the UNORCAC headquarters, where farmers sell vegetables, grains, and other produce. Even though it is not a seed fair, one group explained that some farmers bring seed to sell, which they buy in small quantities to try out. The Agroecological Fair was named as a seed source for common bean, fava bean, pea, and potato while the Seed Fair was only mentioned as a seed source for maize. One possible reason is that pulses and potatoes are often grown in rotation with maize, so farmers may need to acquire seed at other times of the year than when the Seed Fair is held.

Farmers' assessment of the quality of seed obtained at the fairs varied widely. In two communities, participants said the seed was "excellent", while in others they considered it "good" or "acceptable", depending mostly on whether it adapted to their conditions. The availability of seed at the fairs was also viewed differently. One group commented that seed from the Seed Fair is "always" available because that is the fair's main purpose; in other groups it was rated as "sometimes" or "rarely" available because the Seed Fair is held only once a year, or because people do not turn to this source very much. Others noted that at the Agroecological Fair some farmers bring seed and therefore availability is limited.

In addition to local fairs, UNORCAC and its Women's Central Committee, in collaboration with other actors, has carried out several projects in which seed has been disseminated to promote its conservation, including materials from the National Genebank. The "seed given by UNORCAC" was specifically identified as a source of seed for common bean in Morlán, but they noted that this had only happened a few times, and that in some instances germination had been poor. UNORCAC's seed distribution activities were also mentioned in four other focus groups, although they did not identify it as a seed source, possibly because it is very occasional. In one of these communities (San Pedro) farmers said that the seed of some varieties distributed did not grow well, but in San Nicolás and Cumbas Conde no problems were mentioned. According to UNORCAC, the seed distributed was multiplied in the latter two communities, and this may explain why it did not adapt very well in the lower communities.

The use of seed purchased from commercial actors was mentioned in only three communities, but for certain crops these sources represent an important seed source. These cases break with the general pattern of prioritizing farmers' own seed and illustrate changes that have occurred in the seed system in response to environmental and economic factors (Box 1).

Box 1. Cases where commercial actors are an important seed source in Cotacachi

Potato—impact of purple top disease: In Morlán, farmers estimate that they get 90% of the seed they plant from the *carro de papas* (potato truck) that circulates throughout the communities selling ware potatoes. Sometimes they buy seed potatoes at the Atuntaqui and Ibarra wholesale markets (7%), and the rest is obtained occasionally at the Agroecological Fair. They no longer produce their own seed since they were affected by purple top 4–5 years ago. They are now resuming potato cultivation, but they note that the crop continues to be very problematic; they only plant small quantities for home consumption, since it requires a lot of investment for pest and disease control and they fear the return of the disease. In addition, it is difficult to store the seed, so they prefer to use leftover potatoes bought for consumption, choosing the smallest tubers that start to sprout. The varieties obtained from these sources are mostly improved (see below) and are considered "good" quality. The potato truck is considered "always" available as it comes directly to the community, and they note that it is the only local option to obtain potato seed. This situation differs from the other community that analyzed potatoes, San Nicolás, which even produces them for sale. Here too they were affected by purple top, but they have continued to use their own seed (85%) and that of their neighbours (15%), and some even maintain native varieties such as *papa chaucha*. San Nicolás has a higher elevation that favours potato cultivation, although storage remains difficult.

Pea—market opportunities: In the community of San Pedro, pea seed has been obtained mainly from shops (*bodegas*) in Ibarra (70%), followed by farmers' own seed (20%), the Agroecological Fair (5%), *chukchina*[7] on the *haciendas* (4%), and from farmers in the community of Azama in Otavalo (1%). The focus group explained that in the past they used their own seed of the *Chaucha alvici* variety, but they have gradually stopped producing it because of its hard consistency. They have also observed that it does not produce as well and speculate that this may be due to a lack of organic matter in the soil. Some households still cultivate *Chaucha* to make *harinas* and maintain the variety, but it is no longer widely consumed. Over the last three to four years, they have sought other sources of pea seed from outside the community to obtain softer varieties that can be eaten fresh and sold. One of these varieties, *Cahuasqui*, has adapted well and is now the most widely planted in San Pedro. Seed obtained from all the sources mentioned above has adapted well and is considered excellent quality, except for seed from the community of Azama, which did not produce as well as the others. The shops in Ibarra always have the pea seed available, while the other sources are not so reliable. However, once families acquire a variety they like from these external sources, they then start saving their own seed.

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7 San Pedro is the only community where chukchina was mentioned as a seed source. In several other groups, participants noted that chukchina had been used in the past, but the practice is disappearing because the haciendas have now been subdivided or are dedicated to the production of more commercial crops rather than grains such as maize or common bean.

Maize and common bean in a commercialized system: In Peribuela, maize and bean cultivation follows a more commercial logic. Farmers use their harvest mainly for the sale of *choclo* (fresh maize on the cob) and *fréjol tierno* (fresh beans); only 13% of the farmers we interviewed produce dry maize, which they use for home consumption. Unlike in other communities, where maize and common bean are usually intercropped, farmers in Peribuela plant them separately, rotating beans after harvesting maize. For common bean, shops are the most used seed source (41%), followed by farmers from other communities (27%), farmers' own seed (23%), and neighbours or family (10%). They prefer to purchase seed from external sources because they say that saving their own seed is more difficult, as it requires leaving the crop in the field to mature, which is not practical. Shops are the most widely used source because the bean seed is always available. Most farmers considered this seed to be of excellent quality, although some described it as "good", as it sometimes comes mixed with other varieties.

For maize, the farmers mainly use their own seed, with 70% of respondents mentioning that they left a small part of the harvest for seed (after harvesting the fresh maize). While this mirrors the general trend in other communities, there is more use of external sources in Peribuela, including farmers in other communities (17%), neighbours (9%) or family (4%), and—uniquely for maize—shops in nearby towns (9%). Farmers in Peribuela only plant the variety *Maíz leche* (see below). Although some farmers save their own seed and use external sources as a complement, several explained that they prefer to sell the entire harvest to middlemen and then obtain the seed they need for the next cycle from off-farm sources. Seed degeneration is another reason for using off-farm seed sources, with some farmers explaining that when their production begins to decline, they purchase seed from elsewhere to "refresh" their own seed. This logic differs from that of the other communities in Cotacachi, where farmers say they turn to external sources only when they face seed shortages or want to try new varieties. The more frequent use of external sources in Peribuela has also led some farmers to produce and sell seed of the *Maíz leche* variety to farmers in the area, similar to what is seen more widely in Daule among local seed producers (see 3.2).

Transactions and access

A range of transaction types is used to obtain seed, depending on the source (Table 4). These include cash, gifts, exchange, barter and loans. Of these, cash is mentioned most frequently, particularly for external sources such as other communities, fairs and traders. The most common price is USD 1 per pound for maize and legume seed, and USD 0.15 per pound for potato. But in Peribuela prices of up to USD 1.50 per pound are mentioned for seed purchased from other farmers. Where relationships are closer—especially among family members—other modalities become more common. In San Pedro, farmers explain that giving seed as a gift is a way of expressing solidarity among family members. In San Nicolás, participants note that neighbours usually share seed when the amounts are small, but for larger quantities it is sold at the same price as outside the community. In Morlán, the men's focus group commented that bartering takes place when labour services are performed in exchange for seed. However, they note that this practice is disappearing, as families increasingly prioritize cash income and prefer to receive cash payment rather than accept labour in exchange.

Across all focus groups, participants agreed that there are no problems in accessing seed within their communities, as they can draw on any of the sources mentioned above. As one group explained: "In the community everyone has access to fava bean seeds, there is no group that cannot access them. Rather people show solidarity and share seeds among neighbours or family members" (MORO-FGD2). The only exception was the case of potato in Morlán, where seed must be purchased from external sources: "It is difficult for older people to obtain potatoes, whether for home consumption or for seed, mainly because they do not have the money to buy them" (MORL-MU-FGD2, Pos. 238). In Peribuela, participants also expressed the desire to access credit to buy certified seed, suggesting the lack of sufficient financial resources.

Varietal diversity and suitability

Here we present the results of the four-cell analysis (Table 5). For each key crop, a list was compiled of the common names of the varieties cultivated in the community, and these were classified according to the area in which they are grown (large or small) and the number of households growing them (many or few). A fifth cell was included for varieties that are no longer grown or have been lost. Participants then discussed the reasons why certain varieties are cultivated more widely than others, as well as their positive and negative traits. It is important to acknowledge that Cotacachi is an area characterized by high crop diversity, and it was not possible to produce an exhaustive inventory of all varieties present in each community. The classification of their distribution (within the four cells) is also approximate, representing broad community-level trends. For example, in Morlán, where two separate focus groups were held, we observed strong agreement in the varieties identified and their characteristics, but some differences in how they were placed in the four-cell matrix (Table 5). Overall, the main purpose of the exercise was to generate a reflection on the characteristics of the varieties, general trends in their use, and the degree of satisfaction in the main varieties.

Maize: Across the focus groups, participants identified a total of 16 maize varieties grown in their communities. In Peribuela, only the variety *Maíz leche* was mentioned; this is sold as *choclo* to intermediaries who then market it in urban areas (see Box 1). This native variety has displaced other local varieties that were previously grown. In the other communities, between five and ten varieties were named, with greater diversity reported in the higher elevation communities. The principal varieties—grown in large areas by many households in several communities—include *Killu sara* (yellow maize), *Racu bola sara* and *Tzapa sara*. The latter is very soft, used to make *tostado* (toasted maize kernels) and commands a good price on the market, while the first two are used to prepare a variety of dishes. Despite being among the most widely grown varieties, several focus groups noted their susceptibility to pests and diseases and to climate variations.

Other varieties mentioned across several focus groups, but which differ in the extent of their cultivation, include *Yura morocho*, *Killu morocho*, *Yura sara* and *Guandango*. These have a variety of uses. For instance, *Yura morocho* and *Killu morocho* are used as animal feed, for making *coladas* (a thick maize-based drink) and other foods, and they can be sold. *Guandango* and *Yura sara* (white maize) have limited market demand but are suitable for preparing *mote* (boiled maize kernels) and *harinas* and are important in traditional celebrations and rituals. *Guandango* can also be used for *tostado*. In some communities, this group of varieties is cultivated by many households and/or in large areas, whereas in others they are grown only in small areas or have even been abandoned, especially in the lower elevation communities. Experiences also varied in terms of their susceptibility or resistance to pests and diseases.

The remaining varieties identified in the exercise are grown in small areas in the higher elevation communities, such as Cumbas Conde, Morochos and San Nicolás. In these focus groups, participants noted that these varieties are sown specifically to conserve the seed. Some of these varieties have very specific uses, such as *Canguil* for popcorn, *Chulpi* for *tostado*, and *Yana sara* (black maize) for *harinas*. Varieties like *Iritico*, *Julin sara* and *Puca sara* (red maize) are not intentionally planted, but volunteer in the field and are used as animal feed or to make *harinas*. In the lower elevation communities, farmers recalled that varieties such as *Canguil*, *Chulpi*, *Yana sara*, and *Iritico* used to be grown in the past. Other varieties identified as locally

lost are *Allpa guandango sara*, *Canguil negro*, *Chaucha sara*, *Mishka*, and *Sangre de Cristo*.

While most maize varieties identified in the focus groups are local varieties, one hybrid variety—Morochillo—has been introduced for animal feed. It is grown in large areas by many households in Cumbas Conde, but in Morlán, only some households plant it because it requires fertilizer and depletes soil nutrients. Although it is a hybrid, it appears that farmers have adapted it to their own conditions and saved the seed. In both communities, participants noted the risk that Morochillo could displace other varieties of *maíz suave*.[8]

Common bean: In total, 12 varieties of common bean were identified, three of which are improved varieties released by INIAP (Canario, Centenario and Toa). All are cultivated in Morlán, whereas only two to three cultivated varieties were identified in the other communities. This may be explained by Morlán's lower elevation, which is more favourable for common bean. The two most common varieties—named in all communities except Peribuela—were *Chagra poroto* (also called *Misturiado*), and Canario. These two varieties illustrate the balance farmers seek to maintain between cultural values and market opportunities. On the one hand, *Chagra poroto* is a diverse mixture of climbing bean varieties that is managed as a population: intercropped with maize, farmers plant and harvest the mix together, treating it as a single variety. In this regard, the varietal diversity maintained in most communities (apart from Peribuela) is likely higher than that documented in our study. *Chagra poroto* is considered resistant to pests and diseases and well adapted to the area. It is consumed as fresh beans, including during traditional celebrations and rituals, but the dry beans do not fetch a good price on the market. For this reason, many households also plant Canario, which is a climbing bean variety with yellow seeds that sells well, though it is susceptible to diseases and requires chemical inputs. In Peribuela, where beans are usually produced fresh for sale, varieties such as Centenario and *Gema* are preferred. In Morlán, varieties destined for sale also include *Canario pequeño*, *Poroto bolón*, Toa, and *Cargabello*. Apart from *Gema*, all these varieties are considered susceptible to pests and diseases. In both Peribuela and Morlán, these varieties are produced in large areas by many households for the market.

The remaining varieties—such as *Allpa poroto* (also called *Matambre*), *Leche poroto*, *Percal* and *Taytacu*—have little market demand and are only grown in small areas for household consumption. Some varieties are thought to be disappearing. For example, while *Allpa poroto* is cultivated by many households in Morlán for household consumption, in the other communities it is only cultivated by a few households or entirely abandoned. In Morlán, participants mentioned that it is mainly older people who are maintaining varieties such as *Leche Poroto* and *Percal,* while in *Morochos* young people no longer want to consume *Leche Poroto*. Several varieties were only identified in the "no longer cultivated" category. These include: *Conejo poroto*, *José poroto*, *Uribe*, *Virucchuro poroto*, *Yura bolón* and *Yura janzi poroto;* and three types of wild bean: *Popayán*, *Porotón* and *Torta*. In the case of Popayán, participants noted that it is sown on the borders or in the ditches, and although it tastes good, it is being abandoned because it lacks a market outlet.

Potato: The situation of potato differs markedly between the two communities where it was analyzed. In San Nicolás, the improved variety Superchola (commonly called just *Chola*) and the native *Violeta* are grown by many households in large areas. Although they are very susceptible to diseases such as blight, they have nutritional and culinary properties that are highly valued, and they can be sold in town to generate income for their children's schooling. *Papa chaucha* is also popular for household consumption, but has no market in urban areas, so it is cultivated only by a few households and is decreasing in use. In Morlán, where farmers depend on external sources for seed potatoes (see Box 1), they plant improved

8 *Maíz suave* refers to floury-type varieties that can easily be ground and used to prepare a wide range of traditional dishes (*humitas, empanadas, tortillas*). *Maíz suave* is cultivated mainly in the highlands.

varieties such as Capiro, Superchola and Única, as well as *Violeta.* Potatoes are generally only grown in small quantities for consumption and sometimes for sale to neighbours. Some households have lost local varieties such as *Chaucha*.

Fava bean: The two focus groups that analyzed fava bean identified four varieties. In Morochos, *Chaucha grande* is the most widely cultivated due to the large bean size, which is valued for both consumption and for sale, although it is considered susceptible to diseases such as *lancha* (late blight). Although it can be intercropped with maize and common bean, participants observe that it is increasingly being cultivated in plots dedicated only to fava bean. In contrast, *Janzi haba* (small-seeded fava bean), also known as *Chaucha* (grows quickly), is cultivated by only a few households in small areas, as the beans are very hard, even when cooked. Instead, it is used to make *harinas* such as *Uchu Jaku*, which serves to make soups consumed in different community events. However, farmers fear that the variety will be lost because young people no longer want to eat it—neither whole nor as flour. In Cumbas Conde, however, *Janzi haba* is the most widely produced variety, because it is resistant to pests, diseases and climatic variations, and is considered highly nutritious. Even so, participants noted that it has no market, as consumers are unaware of its nutritional value and demand large-seeded fava beans. To sell at the market, some households in Cumbas Conde grow *Haba gruesa*, a large-seeded variety that has the advantage of not requiring chemical inputs. Another variety valued for home consumption, but no market demand, is *Haba shungo rojo*. It is maintained by only a few households in Cumbas Conde and has been abandoned in Morochos.

Pea: Pea was analyzed only in the community of San Pedro. Participants identified three varieties. *Cahuasqui* is the most widely cultivated (by many households, in large areas), while *Chaucha* is grown only by few households in small areas; *Chaucha alvici* has been completely abandoned. As explained above (Box 1), the *Chaucha* varieties are hard-seeded and only consumed in preparations made from *harinas*, while *Cahuasqui* is more appreciated for home consumption and has good market value. However, this latter variety requires much more water compared with *Chaucha*, which is drought-resistant.

Satisfaction with the varieties: In general, all the focus groups indicated that they are satisfied with the varieties they have. Their varieties belong to them, are well adapted to their localities and are appreciated for their diverse culinary uses that sustain their families. As one group explained, "We must thank *Pacha Mama* for giving us food". They also appreciate the market value of some varieties. For example, in Peribuela they indicate that their maize and common bean varieties sell well, while in San Nicolás they note that their potato varieties are appreciated by urban consumers, and that sales generate income to support their children's education and to invest in the *chacra*. Similarly, in Morochos they explain that they are satisfied with the Canario common bean, which is destined for sale, and with the *Chagra poroto* mixture that is used for household consumption.

In several focus groups, participants felt that they do not need any other varieties because their own are already well adapted, and because they fear that varieties brought in from elsewhere may not adapt to the local conditions or require chemical inputs. Some groups indicated that they would rather care for and conserve the varieties they currently have, while in San Pedro participants expressed the desire to recover maize varieties that are being lost, such as *Canguil*, *Chulpi* and *Yana sara*. Although they emphasized wanting to maintain their own varieties, some groups were also open to try new ones. For example, in Cumbas Conde, they explained that trying new varieties of common bean and fava bean is a way of "collecting" seeds adapted to their area. They also noted they would like to obtain new varieties of maize that could generate some extra income. In Peribuela, farmers expressed a similar view as in the other communities. Most farmers stated that they are satisfied with the current varieties of maize and common bean. Some also said they would like to try new varieties that adapt to their area and meet criteria such as better yield and market potential. However, other farmers expressed reservations, noting that it is difficult to find new varieties that adapt to their climate, and sharing accounts of past negative experiences that make them hesitant to take further risks with new varieties.

Suggestions for improving the seed system

When asked whether there had been any improvements in farmers' access to seed in their communities, many participants referred to the efforts that farmers themselves make to produce and select their own seed, and to obtain seed from other farmers or at fairs. In Peribuela they considered it positive that there are now some farmers dedicated to producing and selling seed to other farmers in the community. In some groups, participants also mentioned support from UNORCAC in organizing fairs, distributing plants, fertilizers and seeds (although, as noted above, the seed they received has not always performed well), and training in the production of organic products.

Beyond UNORCAC, participants identified very few external actors that support their seed-related activities, possibly because many actors work through UNORCAC and are not as visible at the farmer level. However, in Morochos farmers mentioned as an "improvement" that they had received seed from plots that INIAP had established to refresh fava bean and white maize accessions. Yet this seed did not perform well in their *chacras*; farmers were unsure whether this was due to different agronomic practices. Some groups also mentioned activities carried out by MAG, such as the distribution of maize seed, agrochemicals and training in vegetable production, but these were considered very occasional. Overall, participants said that there is limited State presence in relation to agriculture, and that support tends to be directed to more commercial producers.

When asked what can be done in the future to improve farmers' access to crop diversity and quality seed, the most frequent suggestion was to maintain varieties that are adapted to farmers' local conditions, and to recover varieties that have been lost. To achieve this, participants put forth several strategies, such as promoting seed exchange to increase access, and supporting UNORCAC's Women's Central Committee to continue distributing seeds. However, in one group they indicated that exchanges should be more effective, since the varieties received do not always adapt. It was also suggested to advance campaigns that support the use of crops that are being lost, as well as to transmit this knowledge to young people. In addition, a range of suggestions emerged for improving the productivity and profitability of agriculture, including training, establishing a space to produce biological inputs, supplying compost to improve soil fertility, adding value to their crops, and improving price regulation by the authorities.

Another concern expressed is to improve farmers' own seed production and storage, including practices to control pests so farmers can store their own potato seed, and use of storage equipment such as metal or plastic tanks. These issues also arose in the Peribuela survey, but with a greater focus on the formal seed system. For example, 35% of farmers spoke of the need for technical assistance from INIAP or MAG on seed management and storage or to establish experimental plots to test the quality of new varieties or to maintain seed purity. A further 26% referred to the need for access to inputs and certified seed, either through subsidies, incentives or direct distribution. One farmer also mentioned the importance of improving seed storage, for instance by using silos.

Table 5. Key crop varieties identified in Cotacachi, their classification in the four-cell analysis, and important traits according to the focus groups.

Crop	Variety (local name)	Type	Classification in the four-cell analysis[9]							Traits		Other comments
			Peribuela	Morlán-men	Morlán-women	San Pedro	Cumbas Conde	Morochos	San Nicolás	Positive	Negative	
Pea	*Cahuasqui*					1				Commercial variety. Good yield by weight. Widely consumed.	Requires a lot of water.	
Pea	*Chaucha*					4				Produces many pods. Drought resistant. Short cycle.	Pea is hard. Only used to make *harinas*.	
Pea	*Chaucha alvici*					5						Pink flowers.
Common bean	*Canario pequeño*				1					Commercial variety. Good price. Produces many pods. Two harvests per year.	Requires chemical inputs.	Bush variety.
Common bean	Centenario	Improved (INIAP)	1		1					Good yield. Two harvests per year.	Variable price. Susceptible to pests and diseases. Requires chemical inputs.	
Common bean	*Gema*		1		1					Commercial variety. Good production. Resistant to pests and diseases.	Variable price. Labour-intensive due to staking.	Climbing variety. Bean is red.
Common bean	*Poroto bolón*				1					Commercial variety, sold as fresh beans. Good production.	Susceptible to pests.	Climbing variety. Bean is round, white or red. Included in *Chagra poroto/Misturiado.*
Common bean	Canario	Improved (INIAP)	Mentioned in the Peribuela survey	2	1	1	2	1	1	Commercial variety. Good price. Produces many pods.	Susceptible to pests, diseases and weather conditions. Requires chemical inputs.	Climbing variety.

9 The categories in the four-cell analysis: 1=Large area, many households (dark blue), 2=Large area, few households (light blue), 3=Small area, many households (dark orange), 4=Small area, few households (light orange), 5=No longer cultivated (grey).

Crop	Variety (local name)	Type	Classification in the four-cell analysis[9]							Traits		Other comments
			Peribuela	Morlán-men	Morlán-women	San Pedro	Cumbas Conde	Morochos	San Nicolás	Positive	Negative	
Common bean	Toa	Improved (INIAP)		1	2					Commercial variety. Good price. Two harvests per year.	Labour-intensive due to staking. Susceptible to pests and diseases. Requires chemical inputs.	Climbing variety.
Common bean	*Cargabello*		5	3	1					For market and home consumption. Good production.	Susceptible to pests and diseases.	
Common bean	*Chagra poroto / Misturiado*			3	1	1	1	3	1	Consumed as fresh beans; used for celebrations and rituals. Good seed production. Resistant to pests and diseases.	Susceptible to drought. No market demand.	A mixture of different varieties that is intercropped with maize.
Common bean	*Allpa poroto / Matambre*		5	3	3	5	4	5		A local variety that has been conserved for a long time. Resistant to pests and diseases.	Requires fertilizer. Limited market. It is being lost.	Bush variety for home consumption. Intercropped with maize. Long, red beans.
Common bean	*Leche poroto*			3	3			4		For home consumption. Resistant to pests, diseases and drought.	No market demand. It is being lost.	White bean. Included in *Chagra poroto/Misturiado.*
Common bean	*Percal*			3						Grown by older people to conserve the variety.	Susceptible to rust.	Bush variety.
Common bean	*Taytacu*			3	3	5				For home consumption. Resistant to weather conditions. Does not need fungicides.	No market demand.	
Common bean	*Conejo poroto*					5		5				Also called *Conejo ishpa poroto*.
Common bean	*José Poroto*					5						
Common bean	*Popayán*						5					Wild, perennial variety. Grows in ditches or field borders.

Crop	Variety (local name)	Type	Classification in the four-cell analysis[9]							Traits		Other comments
			Peribuela	Morlán-men	Morlán-women	San Pedro	Cumbas Conde	Morochos	San Nicolás	Positive	Negative	
Common bean	*Porotón*						5					Wild tree. For human and animal consumption.
Common bean	*Torta*						5					Wild variety. For handicrafts or traditional game called *Tortas*.
Common bean	*Uribe*		5									
Common bean	*Virucchuro poroto*							5				Bean is bright yellow.
Common bean	*Yura bolón*					5						Round, white bean.
Common bean	*Yura janzi poroto*							5				Small and slender white bean.
Fava bean	*Chaucha Grande*							1		For market and home consumption. Large bean.	Susceptible to disease.	Sometimes intercropped with maize and common bean.
Fava bean	*Haba gruesa*						2			Commercial variety with high market demand. No chemical inputs required.		
Fava bean	*Janzi haba/ Chaucha*						1	4		Highly nutritious. Used to make *harinas* because of its hardness. Resistant to pests, diseases and weather conditions.	Small bean. No market demand. Young people no longer consume it.	
Fava bean	*Haba shungo rojo*						4	5		For home consumption. Resistant to pests and diseases.	Not appreciated by urban consumers.	Bean with a red dot in the middle.
Fava bean	Unnamed						5				Bean is hard, even when cooked.	
Maize	*Killu sara*			1	1	1	1		1	*Maíz suave*. For human and animal consumption. It is used to make *harinas*, *mote*, *tostado*.	Susceptible to pests, diseases and weather conditions.	

Crop	Variety (local name)	Type	Classification in the four-cell analysis[9]							Traits		Other comments
			Peribuela	Morlán-men	Morlán-women	San Pedro	Cumbas Conde	Morochos	San Nicolás	Positive	Negative	
Maize	*Maíz leche*		1							Sold as *choclo* (fresh maize on the cob). Sells well in cities. Good production.	Displacing other native varieties.	Milky yellow grain.
Maize	*Racu bola sara*				1	1		1		For food, in different preparations such as *mote*.	Susceptible to pests and weather conditions such as frost and rain.	Plump, round grain.
Maize	*Tzapa sara*				1	1		1		For food, used in different preparations, such as *tostado*. Good price.	Susceptible to pests, diseases and weather conditions.	Flattened, soft grain.
Maize	Morochillo	Hybrid		2			1			For animal feed. No fungicides required.	Requires fertilizer due to high nutrient demand. Cannot be planted intercropped with common bean.	
Maize	*Guandango*		5	5		1	3	1		For household consumption. Used for *mote*, *tostado*, and *harinas*.	No market demand. Grown only by older people. At risk of being lost.	
Maize	*Killu morocho*			3	2	4				For market and household consumption. Used for food (e.g. *coladas*) and for animal feed. Resistant to pests and diseases.	May displace other varieties.	
Maize	*Yura morocho*			2	2	4	1	3	1	For human food e.g. (*harinas*) and animal feed. Resistant to pests and diseases. Can be sold to neighbours.	Large plants that fall over in the wind (lodge). Can cross with other varieties and result in mixed varieties (*amorochadas*).	
Maize	*Yura sara*			3	1	5	3	3		For food, such as maize and *harinas*. Used in celebrations and rituals. Resistant to pests and diseases.	Not sold much. Being lost in certain communities.	

Crop	Variety (local name)	Type	Classification in the four-cell analysis[9]							Traits		Other comments
			Peribuela	Morlán-men	Morlán-women	San Pedro	Cumbas Conde	Morochos	San Nicolás	Positive	Negative	
Maize	*Canguil*			5	5	5	3			Grown to conserve the seed.	The variety is being lost.	
Maize	*Chulpi*			5		5	3	3	4	For food, such as *tostado*. Grown to conserve the seed.	Susceptible to pests, diseases and weather conditions. Being lost.	Grains are red, yellow or black.
Maize	*Iritico*			5			3	3	4	For animal feed. Appreciated for its colourful grains (yellow with black).	Low yield.	Comes up on its own (volunteers).
Maize	*Julin sara*						3	3	4	For food (*harinas*) and animal feed.	Low production. Being lost.	Ash-coloured grains. Comes up on its own (volunteers).
Maize	*Listhtado/ Rayado sara*							3		Sown with other varieties.	At risk of being lost.	
Maize	*Puca sara*								4	Part of the diversity of maize.	Low yield.	Comes up on its own (volunteers).
Maize	*Yana sara*			5	5	5	3	3	4	For food, such as *harinas*.	Susceptible to pests and diseases. Being lost.	
Maize	*Allpa guandango sara*							5				
Maize	*Canguil negro*							5				
Maize	*Chaucha sara*							5				
Maize	*Maíz común*		5									General term used to refer to local maize varieties.
Maize	*Mishka*		5									
Maize	*Sangre de Cristo*			5								
Potato	*Papa chola* (Superchola)	Improved			3				1	For market and household consumption. High nutritional and dietary value.	Susceptible to pests and diseases.	

Crop	Variety (local name)	Type	Classification in the four-cell analysis[9]							Traits		Other comments
			Peribuela	Morlán-men	Morlán-women	San Pedro	Cumbas Conde	Morochos	San Nicolás	Positive	Negative	
Potato	*Papa violeta*				3				1	For market and household consumption. High nutritional and dietary value.	Susceptible to pests and diseases.	
Potato	Papa capiro	Improved			3					Consumed daily. Good production.		
Potato	*Papa chaucha*				5				4	Highly appreciated for household consumption.	Not appreciated in the city. Being lost.	
Potato	Papa única	Improved			3					For household consumption.	Susceptible to pests and diseases.	
Potato	*Papa leona*								5			

3.2 The Coast: the intensive rice system in Daule

The analysis of the local seed system in Daule was based on information collected from focus groups in communities in four rural parishes of the canton: Los Lojas, Daule (rural area), Juan Bautista Aguirre and Limonal. In each parish we identified one rice producers association willing to collaborate in the research. Rice producer associations on the Coast were established in 2008–2010, to receive government subsidies for urea, and they are composed mainly of smallholder farmers, who in Guayas cultivate an average of three hectares of rice (Marín et al., 2021). Although not all rice producers belong to an association, this proved the most practical entry point, particularly because there is a degree of mistrust in the Coast region of Ecuador due to security problems. To select the associations to include in the study, we first consulted the parish government[10] to obtain suggestions of active associations located in relatively safe areas and then approached the president to explore the association's interest in collaborating. We also contacted some associations in the parish of Laurel, but none were willing to participate.

To form the focus groups, we worked with the association presidents to identify up to 10 people who knew rice cultivation well and were willing to participate. Although we sought to convene a separate focus group for both men and women, this proved very difficult since in general few women identify themselves as rice producers, even though they may contribute labour and take part in decision-making (Otero & Alejandra, 2015; Twyman et al., 2015). We made efforts to include women in the focus groups, which was achieved in three of the communities, although they were few (Table 6).

The focus groups were carried out between February and May 2023. Between 8 and 14 people participated in the focus groups, for a total of 40, including 7 women (21%). The exercise was conducted over one day, except in one community where meetings were held on two separate occasions. Participants' ages ranged from 21 to 78, with an average of 52 years. The majority (60%) had completed primary education, while 35% had completed secondary education, and two participants had university or technical studies. All focus groups were made up of association members, except in Juan Bautista Aguirre, where independent farmers were also included.

The four communities differ in their location within the Daule River basin, number of production cycles per year, the average size of landholding, and the points of sale for farmers' rice production (Table 6). In the parish of Los Lojas, the study site is located closer to the estuary, which results in water salinity problems, especially in the rainy season. This limits the number of harvests per year: "We plant in low-lying areas that are prone to flooding, and we have to wait for the waters to recede, whereas our neighbours plant in higher areas and manage up to two harvests a year" (DL-LOJ-FGD2, Pos. 15). This community is also located 6 km from the Daule River, which creates challenges for the maintenance of irrigation canals. The other three communities are situated close to the river that feeds the irrigation system, and they produce between 2 and 3 cycles of rice per year. In the parishes of Juan Bautista Aguirre and Daule, farmers generally sell milled rice; to do so, they take their production to a *piladora* (rice mill), where the rice is milled and sold to buyers. In the communities of the other two parishes (Los Lojas and Limonal), farmers prefer to sell unmilled rice (paddy) to middlemen who come to purchase directly in their fields.

10 In Ecuador, parish, canton and provincial governments are formally designated as Decentralised Autonomous Governments (*Gobiernos Autónomos Descentralizados*, GADs). In this report, for clarity, we refer to them simply as "parish government", "canton government" or "provincial government", depending on the level involved.

Table 6. Characteristics of target communities and the participants in the focus groups in Daule.

Parish	Los Lojas (LOJ)	Juan Bautista Aguirre (JBA)	Daule-rural area (DLR)	Limonal (LIM)
Location of the community	6 km from the Daule River, near the estuary	Next to the Los Tintos River	By the Pula River and a natural estuary	By the Daule River
Irrigation system	Gravity irrigation via canals and re-pumping	Gravity irrigation via an earthen canal	Gravity irrigation via an earthen canal	Irrigation through earthen canals and re-pumping (América Loma irrigation system)
Number of rice cycles per year	1–2	2–3	2–3	2–3
Main point of sale for rice	Intermediaries (unmilled rice)	*Piladoras* (milled rice)	*Piladoras* (milled rice)	Mostly to intermediaries (unmilled rice)
Focus group participants				
Women	2	3	0	2
Men	6	11	10	6
Total	**8**	**14**	**10**	**8**

Crop diversity

Rice

Rice is the most important crop in all four communities, as it is the basis of local livelihoods and a staple food at home: "[Rice] generates 90% of employment and income in the area and is the main product on the table of the Ecuadorian Montubio" (DL-LIM-FGD1, Pos. 20). Some participants also highlighted the importance of by-products such as *polvillo* (rice bran) and *arrocillo* (broken rice) for feeding their poultry and pigs, and the *panca* (stalk and leaves of the harvested plant) used as feed for cattle. They also mentioned agronomic reasons for growing rice: it is a short-cycle crop, performs well in the area, and has fewer diseases than maize in the lowlands. Cultural reasons were also emphasized: "we are used to planting rice" (DL-LOJ-FGD1, Pos. 12), "it has always been this way; our grandparents planted rice, then their children, and so on" (DL-JBA-FGD1, Pos. 11). In the focus groups where women participated, they considered rice to be equally important for men and women: "both sexes live from rice" (DL-LOJ-FGD1, Pos. 23).

Rice cultivation has expanded in all the communities, replacing pastures previously used for cattle. This happened because rice became more profitable, and there were also problems with *abigeatos* (cattle theft). As a result, many people sold their cattle and converted their pastures to paddy fields. Some participants also indicated that the expansion of rice cultivation was encouraged by techniques that improved production (for example, they learned how to level their fields) and reduced labour and production costs (for example, mechanized harvesting). As described in one group, before these improvements, rice was only grown on a small scale: "In those days, the harvest was done manually with a hand sickle, panicle by panicle, [...] after harvesting, we threshed the rice with our feet, and then we had to sun-dry it because there were no *piladoras* around here, so we had to mill it in a wooden mortar." (DL-LOJ-INFO, Pos. 5).

Other "important" crops

In one focus group, farmers argued that rice was the only crop of real importance. However, in the other three communities, participants identified between 4 and 5 crops, in addition to rice, that they considered important in their community, for a total of 10 "important" crops (Table 7). These crops are used mainly for home consumption, as animal feed, and/or for sale. In some cases, they generate significant income for certain households, but overall, they play a secondary economic role compared with rice. Several crops are also valued for their social and

cultural significance, or for the ease with which they are produced:

> Mangoes are second in importance because they require minimal investment, and they are sold, eaten, given to friends as gifts, and used in the production of organic fertilizers (DL-LIM-FGD1, Pos. 20).

> Pigeon pea is used in a range of dishes and is a substitute for *fréjol cholo* [a local bean variety]. […] It is one of the few healthier products we produce without so much application of pesticides and without any inorganic fertilizers (DL-LIM-FGD1, Pos. 17).

These crops are grown in small areas, like the homegarden, along the paddy bunds (earthen embankments bordering the rice fields) or on the riverbank, and in this way, they are integrated into the rice farming system. In one community, participants felt that growing crops on the bunds (referred to locally as "walls") provided an opportunity to increase the production of crops such as plantain: "We didn't use to plant it, but now that the walls are high, plantain is the basis of the family's consumption and we sometimes sell a few bunches, […] the plantains that are damaged are given to the animals" (DL-JBA-FGD1, Pos. 11).

This said, participants highlighted that overall, it is difficult to diversify the rice cropping system: "The land […] has been converted to paddy fields, which makes it difficult to grow any crop other than rice. These are low-lying areas that flood easily, where two harvests a year are taken: the first when the water recedes, around the month of May." (DL-DLR-INFO, Item 5). In the community where they only grow rice, participants said: "We only plant rice, we've tried to plant melon here, but it has not given good results. It is a very delicate crop, and our soils are not so suitable for this type of crop" (DL-LOJ-FGD1, Pos. 15).

In the past 10 years, some crops have also been abandoned. For example, in one community they have stopped planting fruits and vegetables such as watermelon, melon, tomato, squash, pepper, onion and cabbage due to high production costs, pests and diseases, and crop theft.

Table 7. Important crops identified in Daule

Crop	Frequency*
Rice	4
Maize	2
Mango	2
Pigeon pea	2
Plantain	2
Cucurbits (watermelon and melon)	1
Tomato	1
Green bean	1
Pasture/forage grasses	1
Cassava	1

*Number of focus groups that mentioned the crop

Challenges in rice production

In terms of problems farmers face in rice cultivation, the focus groups identified both agronomic and economic challenges (Table 8). At the agronomic level, increases in the incidence of pests and diseases were cited in all the communities:

> Ten years ago or more, when we planted rice, there weren't as many pests as there are now. The harvests were good, up to 4 bags per *tarea* (DL-DLR-FGD1, Pos. 25).

> Pests and diseases are a serious problem for rice production. The *caracol* [snail] appeared from one moment to the next. This happened when they opened the dam to release large quantities of water. When this pest first appeared, it devastated the crops—you planted today and the next day there was nothing left (DL-LOJ-FGD1, Pos. 36).

Another common problem is contamination from the machinery used for land preparation and harvesting, which introduces harmful weeds, nematodes and rice varieties from other fields. This is especially a problem for smallholders who typically pay for these services, but the owners of the machinery do not take the time to clean between every plot. There were also concerns with unevenly levelled paddy fields, poor condition of irrigation infrastructure, and soil salinity caused by the overuse of nitrogen fertilizers.

Table 8. Rice production challenges identified in Daule

Agronomic problems	Economic problems	Seed problems
Pests and diseases	High costs of inputs	Lack of good variety
Varietal contamination	Low price paid for the harvest	Seed degeneration
Soil salinity	Lack of access to credit	
Unevenly levelled paddy fields		
Poor condition of irrigation infrastructure		

Across all the focus groups, the low profitability of rice was a shared concern. Although in the past many farmers invested in rice because its selling price was good, in recent years prices have fallen, while the cost of inputs has increased, particularly fertilizers and pesticides. Another issue is the lack of access to credit, which is difficult to obtain from banks:

> The bureaucracy to secure a loan from public or private banks—they ask for many requirements that we smallholder farmers don't have. For example, the land title: many of us rent land to be able to work. And it generally takes around three months for the loan to be disbursed, by then our crop is about to be harvested (DL-DLR-FGD1, Pos. 32).

As a result, farmers obtain loans from *chulqueros* (illegal moneylenders) or from the *piladoras,* committing the sale of their harvest in advance.

Several focus group participants stated that many times they do not receive a fair price when selling, and that the *piladoras* do not respect the official price established by MAG:

> We invest by lending money from the *chulquero* at a high monthly interest rate, and when we harvest the rice, the *piladoras* pay us whatever price they want. They practically rob us on the weight: it is no longer 200 pounds, now it is 220 or 230 because they don't use the moisture and impurity table. They manage the purchase in this way and there are no State agencies that regulate them (DL-DLR-FGD1, Pos. 32).

This economic situation means that farmers sometimes do not apply the necessary inputs, compromising their yields:

> Production has dropped by 30% in the yield of our current crop due to the overuse of pesticides, and, likewise, the high prices of agricultural inputs that make it difficult to maintain the three fertilizer applications per crop cycle (DL-LOJ-FGD1, Pos. 36).

> In recent harvests, we haven't been able to apply everything that the crop requires because the prices of agricultural inputs—especially fertilizers—have doubled compared to their normal price (DL-DLR-FGD1, Pos. 32).

Another strategy used by farmers in Daule is the practice of *soca*, where a second rice crop is obtained by cutting back the stubble after harvest, burning the residues, and allowing the plants to regrow from the surviving tillers. This technique saves both time and money: "We found there's an easier and cheaper way to produce rice, which is to plant from *soca*" (DL-LIM-FGD1, Pos. 37). In one group they explained that they usually produce the main crop in the dry season from transplants and then implement *soca* in the rainy season. But some are not satisfied with the result: "For several years now we've been planting rice through *soca*, but we're thinking of stopping as it hasn't given good results" (DL-DLR-INFO, Pos. 5).

This dynamic is reflected in farmers' assessment of their last three rice seasons. They attributed "good" seasons to factors such as favourable weather, good-quality water (no salinity), greater investment in inputs, good crop management (soil preparation, management of *soca*), few pests, and good sale prices. In one community, they also obtained good results from using *biol*, a liquid organic fertilizer. In contrast, the seasons considered "average" or "poor" were

affected by unstable weather (e.g., heavy rains, low temperatures), insufficient application and/or poor quality of fertilizers and pesticides (due to financial constraints), pests and diseases, and management problems (e.g., soil preparation, maintenance of irrigation canals). Participants also mentioned challenges related to seed, such as the lack of a good variety and seed degeneration, which is discussed in more detail below.

Seed security

The analysis of seed security focused on rice. In the focus groups, several seed sources used during the most recent agricultural season were identified, including sources of both certified seed and recycled seed (Table 9). It is worth mentioning that no focus group identified their own farm-saved seed as a seed source. Here we discuss each source and farmers' assessments of them in terms of seed quality, availability and accessibility. Later on, we also discuss how they evaluated the rice varieties themselves.

1) Sources of certified seed*:* In the four communities, participants reported that they buy certified seed from seed company outlets or agro-dealers. Other sources of certified seed identified in some groups are CESA (Ecuadorian Centre for Agricultural Services), a non-profit foundation that has organized a group of farmers to produce and sell seed, as well as an initiative of the Prefecture of Guayas that has given away certified seed to producers in some communities. In general, certified seed obtained from these sources represents a low percentage (less than 10%), and some participants indicate that they only buy certified seed as starting material to produce *semilla artesanal* (artisanal seed) as described below.

2) Local seed producers*:* The most important seed source in all communities are local seed producers—farmers who specialize in producing recycled seed for sale to other farmers. Known locally as *productores de semilla artesanal* (artisanal seed producers), they are often referred to simply as "neighbours" because they are from the same or nearby communities. They are estimated to supply between 70 – 80% of the rice seed used by farmers, and they take specific care in managing their seed lots: "Some neighbours who buy certified seed from the seed company outlet and sell it as first-hand seed,[11] […] whoever buys seed has to invest well and look after it, they do all of that" (DL-JBA-FGD2, Pos. 31). Some also produce seedlings ready for transplanting.

3) Commercial rice producers*:* In one community they explained that they sometimes obtain seed from other commercial producers (who produce rice for sale on the market). This source is distinguished from local seed producers because the grain is not produced specifically for use as seed.

4) Unofficial shops: In two communities, participants also identified the use of shops that sell seed without MAG authorization. The first case refers to *almacenes pirata*, informal traders selling uncertified seed, called "pirate" because they operate in places that are not proper shops. Although mentioned in only one focus group, participants indicated that *almacenes pirata* sell to farmers throughout the canton. The other case is a local agro-dealer that mainly sells pesticides, but sometimes also sells seed without a label. According to the focus group participants, this shop works on request from farmers, who ask for the seed a few days before planting.

None of the focus groups identified their own saved seed as a seed source, although in one community they mentioned that "some farmers save their own seed for the next season, and they exchange seed as well" (DL-DLR-FGD1, Pos. 36). However, this seems to be very rare, and most farmers rely exclusively on external seed sources. In all four communities, the farmers explained that this was due to problems with

11 First-hand seed refers to seed that has been recycled once, using certified seed as a starting material.

seed storage, noting that it was becoming increasingly difficult:

> When it comes to storage, we don't have any adequate infrastructure to store the seed. The maximum we can keep it is from one harvest to the next, and that's a period of four months. […] After 6 months the seed gets damaged, weevils get into it. In the past, seed used to last up to a year in storage (DL-LIM-FGD2, Pos. 48).

Some farmers also noted that seed production is difficult because of problems controlling harmful weeds, pests, and diseases. In addition, one group expressed the belief that replanted seed saved from their own parcel would compromise production in the next cycle. For these reasons, farmers nowadays turn to other seed sources.

Seed quality

In general, participants agreed that the highest-quality seed is certified seed: "Of all the seed, the best quality is certified seed, but from recognized outlets. It has 97% germination, strong vigour and growth, good yield, and the grain quality at harvest is excellent" (DL-JBA-FGD2, Pos. 39).

Table 9. Seed sources used and their characteristics, according to the focus groups in Daule.

Seed source	Description	Seed type	No. of focus groups	Importance (% of seed)*	Quality	Availability	Transaction and price for 45kg sack
Authorized sales outlets	Seed company outlets (Agripac, Ecuaquímica) and agro-dealers authorized by MAG	Certified seed	4	3–10% (2/4)	Excellent (3) Good (1)	Sometimes (3) Always (1)	Cash USD 70–80
Non-profit organizations	Certified seed production project (CESA)	Certified seed	2	5% (4/4)	Excellent (1) Good (1)	Sometimes (1) Always (1)	Cash USD 40–42
Government	Seed distribution by the Prefecture of Guayas	Certified seed	2	0–2%	Excellent (1) Unqualified (1)	Rarely (2)	Free (requires application)
Local seed producers	Farmers dedicated to producing and selling uncertified seed (*semilla artesanal*) in their locality	Recycled seed/ seedlings for transplanting	4	70–80% (1/4)	Good (4)	Always (3) Sometimes (1)	Cash USD 24–35
Unauthorized shops	*Almacenes pirata* (local traders)	Unlabelled seed —origin unknown	1	20%	Good (1)	Sometimes (1)	Cash USD 35
	Agro-dealer not authorized by MAG		1	(3/4)	Fair (1)	Sometimes (1)	Cash USD 70
Commercial rice producers	Commercial rice producers not specialized in seed production	Commercial grain	1	15%	Fair (1)	Rarely (1)	Loan, exchange or barter

*In one focus group, the importance of the seed sources was estimated using a ranking instead of percentages (of seed used). For that group we indicate the rank (out of a total of 4 sources), where 1/4 is the most important and 4/4 is the least important.

Although of lower quality than certified seed, seed from local seed producers was rated as "good" in all focus groups. Farmers highlighted characteristics such as good germination and vigour, and the fact that the seed is well managed and carefully handled, for example, harvested by hand to avoid impurities and diseases. Some participants also expressed trust in local seed producers, because they can visually confirm that the seed is free of diseases and weeds. In one group they explained that local seed producers in the area had previously been trained as outgrowers by a seed company, and that they also apply several traditional practices, such as harvesting the seed by hand, harvesting during the waning moon to avoid moth damage, and drying the seed on tarpaulins to prevent contamination with other varieties. One local seed producer further explained that he had appropriate storage infrastructure: "I store it in a ventilated shed with skylights. I place the seed on pallets, so it doesn't touch the cement floor" (DL-DLR-FGD2, Pos. 44).

However, in another focus group they pointed out that there is no quality guarantee for recycled seed: some producers do a good job, but others have poor storage conditions, varietal contamination, and infestations of nematodes and pests in their seedbeds:

> Yes, there are many farmers who sell top-quality seedlings, free of pests and diseases, who take care of their seed and look after their business [...] But there are others in neighbouring areas who sell seedlings ready for planting that do not meet phytosanitary standards (DL-LIM-FGD1, Pos. 52).

Seed from the *almacenes pirata* was considered "good quality" and is also sold at a price similar to that of the local seed producers (Table 9). It seems likely that these shops are supplied with—and sell—seed from such seed producers, although we could not confirm this.

Two sources were rated as "fair". One is grain from neighbours who produce commercial rice, since it is not managed as seed. The other is the agro-dealer, mentioned in one community, that sells unlabelled seed, which farmers say does not germinate well. Although this was a specific case, another focus group also expressed distrust in "certain" agro-dealers who sell poor quality seed, and in some local seed producers who do not manage their seed lots well.

Seed availability

Experiences with the availability of seed from local seed producers—the main source—were mixed. In three of the four focus groups, participants felt that seed was "always available" in sufficient quantities at planting time. However, the fourth group said that sometimes they cannot obtain enough seed from local seed producers in their area when they need it:

> No, sometimes in April we have to go around looking for seed, because they [local seed producers] sell out and they tell you to wait. And other times, if they've just harvested it, they tell you that you have to wait about 20 days and pay 50% up front, because if you take it now when it is fresh, it won't germinate, and they won't give you any guarantee (DL-JBA-FGD2, Pos. 58).

In another group, participants noted that when seed is scarce, they may not be able to find the variety they want, or they may have to resort to poor quality seed: "Every year we have problems getting seed because it runs out, and we have to buy recycled seed that hasn't been well handled at harvest or post-harvest—often it comes with mould" (DL-DLR-FGD1, Pos. 36).

There were also varying experiences with CESA. While some participants noted that CESA plans well so to provide seed throughout the year, others had faced certain challenges: "Sometimes the seed is not ready for sale because it has not yet completed the dormancy needed before selling it to ensure good germination" (DL-LIM-FGD2, Pos. 53).

The group that identified the *almacenes pirata* as a seed source noted that seed becomes scarce in certain months due to high demand in the canton. All of the focus groups mentioned that the same phenomenon used to occur in the seed company outlets when there were subsidy programs for certified seed, particularly the distribution of the "kits" from MAG's *Plan Semillas*. Availability problems also happen in points of sale that do not have facilities for long-term seed storage (*puntos de venta transitorios*): "Because it's a shop

without adequate infrastructure for proper storage of certified seed, there are times when it's not available" (DL-LOJ-FGD2, Pos. 60).

Two sources were classified as "rarely available in sufficient quantities". The first is commercial rice producers, who may not have surplus grain, and are only approached in cases of extreme need. The second is the Prefecture, due to limited quantities of seed and uncertainty about the continuity of the initiative: "The maximum a farmer can get is just three sacks, and we still don't know how often they'll give this support [...] it's like they just show up and then disappear" (DL-LIM-FGD2, Pos. 27, 53). Participants also felt that the initiative was politically motivated: "This year the Prefect gave two 45 kg sacks of seed per person. It's the first time that she's given us seed, and we believe that she only did it for the political campaign" (DL-LOJ-FGD2, Pos. 36).

Seed access

For farmers in Daule, access to seed depends largely on economic factors. Seed prices vary considerably between sources, with local seed producers being the cheapest (USD 24–35), followed by CESA (USD 40–42) and finally seed company outlets or agro-dealers (USD 70–80) for a 45 kg sack. Although farmers appreciate the quality of certified seed, not all farmers have the means to buy it*:* "Sometimes we buy seed from the seed company outlets, but very few farmers can access this seed because of the high price" (DL-LIM-FGD2, Pos. 27).

In several focus groups, participants said that certified seed was used more in the past, but the current economic situation no longer allows it: "The use of recycled seed has gone up, mainly because the price of rice has fallen—as we say, it was through the floor, very cheap—and certified seed was very expensive. No one is going to plant just to lose money" (DL-LIM-FGD2, Pos. 30). Faced with this situation, farmers turn to local seed producers, whose seed they generally consider to be of good quality and affordable.

Relationships of trust among "neighbours"—a term often used to refer to local seed producers—also facilitate access to seed. Cases were mentioned in which local seed producers provide seed on loan, to be paid at harvest without interest, or in which they provide additional seedlings if needed:

> Seedlings ready for planting are paid for in cash. You can buy several rows of seedlings to plant a *cuadra* and pay between 60 and 70 dollars. But if you run short of seedlings, you can go and speak with the person who sold them to you, and they'll let you take the amount you're missing so you can finish planting your whole *cuadra* at no extra cost (DL-LIM-FGD2, Item 63).

Some participants said that seed exchange does not exist on the Coast, but one focus group pointed out that seed from commercial rice producers is mostly obtained through loan, exchange or barter. As they explained, this is a last resort only used when money is short: "The seed the neighbour produces is for commercial sale as grain, not for seed. We turn to this source when we don't have money to buy certified seed or seed from [the local seed producer]" (DL-LOJ-FGD2, Pos. 49).

Even though CESA offers certified seed at a reduced price compared with commercial actors, currently it contributes very little to the seed system. One focus group estimated that in the past CESA had been the main source in their community, providing up to 60% of the seed. They explained that many farmers stopped using this source because, for a time, there were quality problems: "People lost confidence, because there was a time when the seed came mixed with other varieties, and the quality went down. Now the CESA seed plant [...] maintains excellent seed quality" (DL-LIM-FGD2, Pos. 30). As described in the next section, changes in the varieties planted are another important factor influencing the use of this source.

In 2022, certified seed was distributed at no cost by the Prefecture. According to the focus groups, to access this program, farmers needed to belong to a producers' association and complete some administrative steps, after which they could collect the seed from a company outlet. Due to these requirements, participants noted that access was not always assured: "it is not accessible to all of us, and we don't always get it" (DL-LIM-FGD2, Pos. 42).

Varietal diversity and suitability

The focus groups identified between four and seven varieties of rice currently grown in their community, for a total of 9 varieties overall. All are improved varieties; however, Valor and Ferón are not registered in Ecuador. In addition, 13 varieties that are no longer cultivated were mentioned (Table 10).

Farmers obtain seed of almost all varieties from informal sources, such as local seed producers, commercial rice producers, or *almacenes pirata*. SFL-011 and Impacto, a new INIAP variety, are the main varieties obtained from seed company outlets or agro-dealers, and both varieties were also included in the Prefecture of Guayas' seed distribution initiative. CESA was mentioned as a source of the variety INIAP FL-Arenillas, although in the past CESA has also produced INIAP-11, INIAP-14 and INIAP-15. However, INIAP no longer produces registered seed of these varieties. Overall, the informal system is maintaining much of the varietal diversity that is grown in Daule, although some varieties have also been lost, including some older improved varieties such as INIAP-12 and INIAP-415.

According to the focus groups, the most widely grown varieties across the communities are SFL-011, INIAP-11, and SFL-09. Of these, SFL-011 is the most dominant, being grown in "large areas by many households" in all four communities. Furthermore, its cultivation is reported to have increased in recent years. The situation for INIAP-11 and SFL-09 varies, with these being grown by many households in some communities and not in others (Table 10). The remaining varieties are generally grown by only a few households. This pattern is mainly explained by their market value, although other agronomic and culinary factors also influence farmers' varietal decisions (Table 10).

SFL-011 has been the most widely planted rice variety on the coast for several years, mainly because of its market price, which farmers say is between 2 and 4 dollars more per 45 kg sack compared with *arroz corriente* (varieties that are not paid a premium—usually short grain). Participants note that it has better acceptance in the market because it mills well and has good cooking properties for the high-elevation conditions in the Sierra, which is the main market for the rice industry in Ecuador. However, almost all participants felt that SFL-011 is not good for home consumption, especially due to its coarse texture (*áspero para comer*). Although one participant argued that "you have to know how to cook it, because my wife adds plenty of water and it comes out great" (DL-DLR-FGD2, Pos. 84), others said they prefer to exchange or buy other rice varieties for home consumption. SFL-011 also has several agronomic drawbacks: it has a longer cycle than other varieties; it is susceptible to lodging, especially in the rainy season if direct-seeded; and while some farmers consider it resistant to pests and diseases, others find it to be susceptible: "It's very pest-prone—the stem borer attacks it when it's heading, and caterpillars like to feed on the rice head, causing it to dry out." (DL-JBA-FGD2, Pos. 84).

In general, the other varieties have advantages in their agronomic and culinary characteristics compared to SFL-011. For example, INIAP varieties are particularly considered "pleasing to the palate" (DL-DLR-FGD2, Pos. 77), and several farmers continue planting them for home consumption. Moreover, fast maturation is also important for adapting to climatic variations, as one participant explained about INIAP-11: "In our experience this variety is good. It has given us good results in yield per hectare; it has a short cycle, which is what farmers in this sector need. We are planting it now because El Niño is coming, and with this variety we can harvest almost a month earlier" (DL-LOJ-FGD2, Pos. 92). Another reason for planting varieties other than SFL-011 is the belief, expressed in one focus group, that the variety should be rotated every two years to maintain good production. Nonetheless, this was not mentioned in other groups, and it is not clear to what extent this practice is followed.

Some of the INIAP varieties are considered resistant to pests and diseases, but in two communities participants reported that INIAP-14 has become susceptible. One participant blames the practice of recycling seed:

> [INIAP-14] was one of the most widely planted varieties in the sector when it first came out, because it was a short-cycle variety, resistant to *cinta amarilla* (rice hoja

> blanca virus). But as always, because we did not buy certified seed and we recycled the seed without adequate knowledge, the variety deteriorated and became [susceptible] to pests and diseases, lowering production considerably. So, we stopped planting it (DL-LIM-FGD2, Pos. 82).

SFL-09 is another variety that many farmers like, which they consider better for eating, drought-resistant, with better yield and a shorter cycle than SFL-011. Some participants expressed frustration that this variety is paid as *arroz corriente*, even though it is long grain: "Excellent experience with this variety [SFL-09] because it has all the qualities needed to be number one in national sales, but unfortunately here in Ecuador, the rice industry is the one in charge, and they consider it *arroz corriente*" (DL-LOJ-FGD2, Pos. 92).

Some farmers have even experienced difficulties in selling varieties such as SFL-09 and INIAP-11 at all: "There are times when they won't even take it for free", said one farmer (DL-JBA-FGD2, Pos. 84).

Some farmers are satisfied with SFL-011 because of its commercial value, but several said that they do not plant the varieties they actually prefer:

> We would like to plant other very good varieties, which are resistant to pests and diseases, like Ferón, but they pay it as arroz Corriente. […] That is why around 80% of our land is planted with SFL-011 (DL-LIM-FGD1, Pos. 43).

Another farmer commented:

> You could say that the only rule that governs the use of seed is set by the rice industries—they're the ones who tell us which varieties they're buying. So, even if we do not like that variety, we're forced to plant it (DL-LIM-FGD1, Pos. 88).

Considering new varieties that may be produced in the future, participants emphasized the desire for varieties that meet their criteria:

> Varieties with a shorter cycle, about three months, that meet three criteria: good to eat, good production, and good price (DL-LOJ-FGD2, Pos. 95).

> We always need new varieties that are resistant to pests and diseases. If you could combine of SFL-011 and INIAP-11 it would be great—that way you'd have a long-grain variety that's also good to eat (DL-LIM-FGD2, Pos. 85).

Suggestions for improving the seed system

Focus group participants in Daule made several suggestions for improving farmers' access to quality seed of their preferred varieties. The main suggestion was to strengthen the seed production by farmers themselves—i.e. of local seed producers—so that they can produce their "own certified seeds" (i.e., higher-quality *semilla artesanal*). Specific proposals included offering training on seed production and storage, having access to early generation seed to produce higher-quality seed, and establishing a seed processing plant to cure and store seed. As explained in one group:

> We really need a seed processing plant in the community […] to ensure quality, like the CESA plant. […] It should be an institution that is always looking out for farmers' well-being. There are other farmers here who have well-levelled fields who could multiply seeds. They could be seed growers in the area […] and supply seed to farmers (DL-DLR-FGD1, Pos. 62).

Participants in Los Lojas expressed the desire to "have a *piladora* in the sector that pays a fair price and gives a good grading to our product" (DL-LOJ-FGD1, Pos. 87). This, they said, would help improve the profitability of rice production and farmers' ability to access quality seed. It is worth noting that this community currently only sells unmilled rice (paddy) to intermediaries.

Other suggestions are aimed at improving plant genetic resources. For example, participants recommended

that breeding programs develop a new rice variety that better responds to their preferences, with the direct participation of farmers. In addition, one group came up with the idea of setting up demonstration plots with other crops, so that farmers can learn how to make better use of the bunds of the paddy fields and diversify their production.

At the level of the State, participants mentioned the need for policies and programs that support farmers and continue from one government to the next. Here they explained, "the Government should invest in technology transfer on a permanent basis", with the support of a field technician who becomes involved in the community, as opposed to "technical assistance", where farmers are just told what to do (DL-LIM-FGD1, Pos. 104). They also suggested that the canton-level government be more involved in the rice sector, so that support is closer to farmers and better aligned with their needs.

When we asked the focus groups whether there had been improvements in farmers' access to seed in recent years, very few were identified. One exception was the experience in which a small group of farmers recruited as outgrowers for a private company, received training from MAG technicians: "The private company PRONACA set up seed multiplication plots of the variety SFL-011 with a small group of farmers from the sector who met the required conditions, and were trained by MAG agronomists" (DL-DLR-FGD1, Pos. 40). According to the participants, some of these farmers later became local seed producers and were able to use the techniques they learned in the production of *semilla artesanal.* Another group also highlighted the annual *expoferia* (agricultural trade fair) held in the cantonal capital, where farmers can learn about different seed varieties through exhibitions by the country's major agrochemical companies.

Table 10. Rice varieties cultivated in the four communities, their classification in the four-cell analysis, seed sources used, and evaluation of varietal traits.

Variety	Classification in the four-cell analysis*				Seed sources**		Evaluation of varietal traits***		
	LOJ	JBA	DLR	LIM	Formal	Informal	Market	Agronomic	Culinary
SFL-011	1	1	1	1	X	X	Best price, good milling yield, high market demand, good cooking quality for the Sierra (at higher elevation).	Good yield, but long cycle. Susceptible to lodging. Some find it susceptible to pests and diseases.	Coarse texture
INIAP-11	1	2	1	3		X	Lower price.	Resistant to lodging and spoilage. Resistant to pests and diseases. Good yield. Short cycle.	Good taste and good to eat.
SFL-09	1	3	2	4		X	Lower price.	High yield. Drought resistant. Shorter cycle than SFL-011.	Good to eat.
INIAP-14		4	3	4		X	Lower price.	Good yield/production. In one community, it has become susceptible to pests and diseases.	Good to eat.
INIAP-15		4	4			X	Lower price.	Good yield/production. Resistant to lodging. Short cycle.	Good to eat.
INIAP FL-Arenillas	2		4		CESA	X	Light grain that breaks during milling. Low price, buyers don't want to purchase it.	Short cycle, resistant to lodging. Some say good production and others say low.	
Value			4			X	Excellent grain quality but not accepted in the market.		Good to eat.
Ferón	2					X	Light grain, low milling yield.	Good yield. Resistant to pests and diseases	
INIAP-Impacto	2				X		Low milling yield. Buyers don't want to purchase it.	Good yield.	Good to eat.
Varieties no longer grown in one or more communities: INIAP-415, INIAP-12, 1001, Blu Gone, Caña Brava, Canilla Viejo, Chepa de Gringa, Conejo, Donato Patucho, Enchotado, Ferón, R8, Tailand. Note: INIAP-415 and INIAP-12 were mentioned as abandoned in 2 communities; the other varieties were only mentioned in one.									

*In the four-cell analysis, varieties were classified according to their distribution in the community: 1=planted in large area by many households (dark blue), 2=planted in large area by few households (light blue), 3=planted in small area by many households (dark orange), 4=planted in small area by few households (light orange).

**Formal sources include seed company outlets, agro-dealers, and CESA; informal sources consist of local seed producers, commercial rice producers, and *almacenes pirata*.

***Colours were assigned by the research team to summarize the traits: positive traits (green), negative traits (red), mixed positive and negative (yellow).

Maíz leche, a local variety grown by farmers in Peribuela (Cotacachi canton), is sold mainly as choclo to intermediaries for urban markets. Some farmers leave one or two rows in the field to dry for seed, while others purchase seed from local producers such as Ricardo. Photo: Luis Salazar/Crop Trust.

4 SEED SYSTEM FUNCTIONS: THE BROADER CONTEXT

This chapter analyzes the roles and activities of key actors involved in the core seed system functions: conservation and maintenance of diversity, varietal development, seed production, and seed dissemination. We draw on the local experiences in Daule and Cotacachi, but the goal here is to understand how the seed system functions from a broader perspective, considering the contributions of actors at local, regional and national levels. We also discuss the strengths and challenges identified for each function, and the influence of governance and other contextual factors.

4.1 Variety development and management

Variety development and management includes activities for conserving and maintaining plant genetic resources, both in farmers' fields *(in situ*) and in genebanks, living collections, or botanical gardens *(ex situ*). It also encompasses variety development, including selection, adaptation and breeding activities.

Conservation and maintenance of diversity

Farmers have always played a central role in the management and development of crop diversity. In Cotacachi, farmers cultivate a high diversity of crops, which is closely tied to cultural values. Skarbø (2014), for example, documented 103 species cultivated in Cotacachi for food and medicine, and found higher levels of diversity in families who identify with Kichwa cultural values and practices and who mainly produce for their own consumption. Even with pressures linked to limited market opportunities and changing food habits, Kichwa traditions remain vital for maintaining crop diversity. This includes many native and traditional varieties, together with some improved varieties. The situation is quite different in Daule's rice production system, where we did not record any *criollo* (local) varieties of rice being cultivated. According to Andrade and Loor (2010), MAG estimates that the area planted with traditional rice varieties decreased from 71% in 1968 to 12% in 1992, indicating significant genetic erosion. The same study identified 54 traditional rice varieties that were previously cultivated in the Coast region of Ecuador. Even so, farmers do maintain some diversity in the bunds of the paddy fields, in homegardens and along riverbanks; they also cultivate, on a small-scale, some older improved rice varieties that are no longer produced in the formal system. These practices are motivated in part by their culinary uses, but production in Daule is much more commercially oriented. According to one interviewee, about 10 years ago, farmers in Daule used a wider range of improved rice varieties, selecting those that were best suited to their conditions and rotating between varieties to control diseases and pests and reduce fertilizer use. However, these practices have declined with the dominance of SFL-011 in the market.

The National Genebank, maintained by the National Department of Plant Genetic Resources (DENAREF) of INIAP, is the most important *ex situ* collection in the country, with 28,654 accessions from 500 species, of which 82% originate in Ecuador. The accessions are conserved across six INIAP experimental stations, located in the Sierra, Coast and Amazonia, and include orthodox seeds (60%), living collections (36%) and *in vitro* materials (4%) (Crop Trust, 2022). In addition to *ex situ* conservation, DENAREF also collaborates with other entities, such as farmer organizations, local governments and the Agrobiodiversity Bioknowledge

12 Some CBDAs are called "Agricultural Bioknowledge and Development Centres" (*Centros de Bioconocimiento y Desarrollo Agrario*), but in the LOASFAS they are called "Agrobiodiversity Bioknowledge Centres" (*Centros de Bioconocimiento de la Agrobiodiversidad*).

Centres (CBDA),[12] to carry out activities that promote the conservation and use of agrobiodiversity. These include the rescue of threatened diversity and restitution of genebank accessions to local communities, seed and marketing fairs, and agrobiodiversity education programs. DENAREF is also Ecuador's focal point for the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

The DENAREF collection contains important and unique accessions of many Andean and Neotropical crops. However, there are also challenges in maintaining such an extensive collection, several of which are being addressed through the BOLD project (Crop Trust, 2022). For example, there are inadequate resources and procedures for monitoring and refreshing accessions, which may pose a risk to maintaining the collection. There are also several bottlenecks that limit the use and distribution of germplasm. On the one hand, the database of available accessions is not accessible online, which prevents interested users from knowing what is held by the genebank. On the other hand, the process for requesting materials is very lengthy and can discourage many actors. This process is governed by the National Regulation on Access to Genetic Resources, in line with the rules set out in international agreements such as the ITPGRFA and the Nagoya Protocol to the Convention on Biological Diversity. For national and international institutions, this requires an Access Contract, which stipulates certain conditions to prevent misappropriation of plant genetic resources and to ensure that benefits derived from the use of germplasm are shared fairly. However, the process is complex, and the institutions responsible for administering it—SENECYT for research purposes and INABIO for commercial purposes—do not have the capacity to fulfill this role effectively. As a result, the main users of the genebank are INIAP's plant breeding programs and the communities involved in DENAREF's germplasm restitution activities. For these actors, access conditions are more straightforward. Certain conditions still apply—for example, materials cannot be passed on to third parties—but the process is simpler and can be handled directly by the genebank. In the case of the farmers, since the germplasm originally came from them, a simple declaration is prepared indicating that the materials are being returned to the communities. Within INIAP, programs must submit a formal request following the institute's internal procedures.

In addition to DENAREF, several universities and other institutions maintain genebanks with more specific collections. For example, the Pontificia Universidad Católica del Ecuador conserves 540 accessions, mostly collected in the north of the country, which are used in student theses and university research. INABIO has the authority to regulate genebanks nationally and is working to establish a National Genetic Resources Bank composed of a network of seven different genebanks, including INIAP and several universities.[13] There are collaborations between these banks, for example, to conserve safety duplicates of their accessions. Notably, one genebank is held by the agrochemical company INTEROC, which was acquired from a company in Colombia in 2020 and transferred to Ecuador. This genebank contains 58,000 rice accessions, obtained through transfer agreements with international genebanks, which are used in the company's breeding program. INTEROC indicates that 70% of the accessions are characterized at phenotypic level and 20% at genotypic level.

Other actors promoting *in situ* conservation and use of agrobiodiversity include farmers' organizations, CBDAs, national non-profit organizations, and international organizations such as FAO and the International Potato Centre (CIP). One of the main strategies of these organizations is to promote exchange of both seed and knowledge among farmers, through seed fairs, *diálogos de saberes* (knowledge-sharing dialogues), and other mechanisms (see Section 4.3 for more details). Another strategy focuses on promoting the valorization of native and traditional crops through alternative marketing channels, bio-enterprise initiatives, and efforts to strengthen value chains.

13 http://inabio.biodiversidad.gob.ec/2021/08/11/autoridades-coreanas-y-ecuatorianas-conocen-mas-de-la-propuesta-del-banco-nacional-de-recursos-geneticos-del-inabio/

This also includes consumer education about the nutritional value and culinary uses of agrobiodiversity, which are often not widely known, particularly in urban areas. These urban preferences also influence dietary habits in indigenous communities—especially among youth—as seen in Cotacachi.

CBDAs are local spaces where participatory research, conservation and learning activities take place to support the recovery and use of agrobiodiversity and traditional knowledge (Paredes et al., 2014). Based on our data, 11 CBDAs have been established or are in the process of being established, managed by farmers' organizations, local governments, universities or public institutions; however, several of these are no longer functioning (Table 11).

CBDAs typically have a plot of land where they maintain a seed collection and/or botanical garden of local crop diversity, where educational and productive activities are carried out. A leader from UNORCAC explains that students and visitors go there and "it is important because the Centre holds all the communities' knowledge on plants and seeds, so we show them and explain what the plants are for and why it is important to maintain the seeds" (CO-KII-05, Pos. 135). CBDAs managed by universities involve students in their activities. For example, at the Technical University of the North (UTN), students help to maintain the CBDA collections and, through teaching and research activities, take part in biodiversity initiatives along the entire value chain, from seed to cultivation, to culinary and agro-industrial uses, and to the broader ecosystem functions this biodiversity supports.

Many of the CBDAs have been supported by INIAP, and they are a strategic partner for linking the National Genebank with local communities for *in situ* conservation initiatives, as explained by a DENAREF representative:

> A farmer might come to ask me for potatoes, but I have 400 types of potatoes—which one am I supposed to give them? But if you take a different approach, let's say you're in Chimborazo and they want native potatoes, to recover their native potatoes, you come to the database here and see which materials you have brought from Chimborazo. You take 50 or 60 accessions to the CBDA and carry out participatory characterization with them, and then you say, "Of these materials you are seeing here, which ones do you want to take back?" And then, through a system of local seed producers, they multiply them for others. That's how we are working in Chimborazo with potatoes (EC-KII-06, Pos. 128).

CBDAs are recognized in Article 20 of the Organic Law on Agrobiodiversity, Seeds and Promotion of Sustainable Agriculture (LOASFAS), which establishes that the State "shall finance, support and advise on the proper functioning" of CBDAs (República del Ecuador, 2017). In the first open call of the Agrobiodiversity, Seed, and Sustainable Agriculture Research Fund (FIASA) in 2023, established under the LOASFAS, three projects to support or establish CBDAs were funded,[14] but there is no fixed budget allocation for CBDAs. As a result, CBDAs depend mainly on the internal resources of the managing organization, and often on the leadership of key individuals—which is both a strength and a weakness. For example, changes in leadership within local governments have caused some CBDAs to stop functioning, while UTN estimates that during the pandemic they lost 10% of conserved materials due to lack of student labour. According to several interviewees, developing strategies to ensure the sustainability of CBDAs is important for this model to function effectively.

14 https://www.iniap.gob.ec/ganadores-convocatoria-abierta-fiasa-2023/

Table 11. CBDAs established in Ecuador. Sources: Paredes et al. 2014, Valverde et al. 2018 and FIASA data.

Region	Province	Canton (Parish)	Managing organization	Year of establishment	Current status
Amazónica	Morona-Santiago	Taisha	Universidad Técnica de Ambato	In the process of being established	
Amazónica	Orellana	Loreto	Organización de mujeres Kallary Muskuy Warmi Wankurishka (OCKIL)	Before 2014	Non-functional
Costa	Manabí	Santa Ana (Ayacucho)	Comunidad Río Caña	Before 2014	Non-functional
Insular	Galápagos	San Cristóbal (El Progreso)	INIAP-Granja Experimental Socavón	2016	Functional
Sierra	Azuay		Gobierno Provincial del Azuay	In the process of being established	
Sierra	Chimborazo	Guamote (Totorillas)	Gobierno Municipal de Guamote	Before 2014	Non-functional
Sierra	Chimborazo	Riobamba (Las Abras)	Gobierno Provincial de Chimborazo	Before 2014	Non-functional
Sierra	Chimborazo	Riobamba (Licto)	Escuela Superior Politécnica de Chimborazo (ESPOCH)	2018	Functional
Sierra	Imbabura	Antonio Ante (San José de Chaltura)	Universidad Técnica del Norte (UTN)	2015	Functional
Sierra	Imbabura	Cotacachi (San Francisco)	Unión de Organizaciones Indígenas y Campesinas de Cotacachi (UNORCAC)	Before 2014	Functional
Sierra	Loja	Catacocha	Empresa Pública de Desarrollo Productivo y Agropecuario del sur (DEPROSUR)	Before 2014	Non-functional

At the State level, the Subsecretariat of Family and Small-Scale Farming (AFC) is a new unit within MAG, established in 2017, responsible for promoting *semilla campesina* (seed managed by farmers) and ancestral knowledge related to agrobiodiversity. AFC implements programs with farmers, which include training in agroecology, seed fairs, and bio-enterprise initiatives, among others. It also manages the *Registro Nacional de Semilla Campesina*, as established in the LOASFAS, a register aimed at monitoring the status of "native seeds" (local or traditional varieties of native crops) in the country. This work is carried out mainly through *casas de semilla*, local seed collections maintained by an organization (such as a CBDA) or an individual. AFC provides these custodians with containers for storing seeds and training in conservation techniques. The goal is to compile information about all the native varieties kept in the *casas de semilla* and use this data to establish a baseline; however, this baseline has not yet been established. Another line of work is the recovery of ancestral knowledge, undertaken through *diálogos de saberes* with elders and youth to promote intergenerational transmission. Together with the knowledge holders, AFC collaborates with the National Intellectual Property Service (SENADI), to register ancestral knowledge as "intangible cultural heritage".

In general, *in situ* conservation efforts in Ecuador focus on the Sierra and other zones of high biodiversity. This corresponds to an explicit State policy, aimed at maintaining the diversity that exists in these areas. For example, Article 20 of LOASFAS indicates that the State will identify "agrobiodiversity zones", where initiatives for the conservation and sustainable use of plant genetic resources will be prioritized. On the Coast, there are efforts to recover agrobiodiversity in certain areas where some traditional varieties of rice and maize are still maintained. For example, in Manabí, INIAP's maize program is working on the rescue of *maíces criollos* (local maize varieties) with specific cultural uses, such as varieties used to prepare *salprieta* (a toasted peanut and maize seasoning) and other traditional dishes. In Guayas, some NGO-led projects have promoted agroecology as a strategy to increase resilience to hazards such as flooding (Guzñay D., 2016; Rodríguez, 2016). Even so, there appear to be few efforts to support the use of crop diversity in areas such as Daule, where production is much more commercially oriented.

Variety development

In addition to contributing to the conservation and maintenance of diversity, farmers actively generate new diversity in their localities through selection and adaptation of varieties they obtain from different sources. Sometimes seed is brought in from far away. For example, a farmer from Cotacachi who spent time in Colombia explained:

> With *chocho*, it was the same—I brought some back. They had a garden there in Colombia, so I brought a handful. Every time I went out, I would pick some, opening the pods and collecting them, and I brought it back here. And that is the *chocho* I have planted here—we have made it grow here. [...] I see that the *chocho* I have has turned out quite nice and produces many branches—it's improved now, this *chocho* (CO-KII-01, Pos. 102).

Some farmers within the Red de Guardianes de Semillas are also working to adapt vegetable seeds, such as lettuce and tomatoes, with the aim of developing local varieties. Beyond their own innovation processes, farmers also collaborate in INIAP's breeding programs, described below. According to INIAP researchers, participatory plant breeding approaches have been incorporated in their programs since the 2000s. Participatory plant breeding can take many different forms, ranging from more consultative processes where researchers retain most decision-making power, to approaches led primarily by farmers (Westengen & Winge, 2020). INIAP has involved farmers mainly by collaborating with producer groups in the later stages of breeding, to evaluate and select materials under local conditions. As one INIAP researcher explained:

> This was important because we made fewer mistakes. If I take 20 or 30 lines to [the farmers] and we plant them in several sites and work with them, [...] they have more experience, because they are there every day. They have specific criteria—many things we sometimes don't know. So, when they observed all the lines, they would say 'I like this,' 'I don't like this,' 'No, I don't like this panicle,' 'No, this one won't sell in the market'. And it was precisely those criteria that we incorporated into the selection of future varieties." (EC-KII-08, Pos. 99).

However, there are also cases in which farmers have been involved from the earliest stages of the process, contributing, for example, to defining the breeding objectives themselves.

In the formal system, new varieties are introduced through breeding programs or by importing varieties from abroad. In both cases, before they can be commercialized, they must undergo a process for registration and release, according to the procedures established in the LOASFAS (República del Ecuador, 2017). Cultivar registration is managed by MAG, and as part of the requirements, applicants must provide validation trial results conducted or supervised by INIAP. These trials verify: a) adaptation to a defined agroecological zone; b) agronomic and/or agro-industrial validation, according to the cultivar's

technical dossier; and c) validation of the varietal descriptors reported by the applicant.

According to data from the *Registro Nacional de Cultivares* (National Cultivar Register) (Table 12), INIAP has registered most cultivars for crops of importance in the Sierra—such as *maíz suave*, potato, common bean, fava bean and pea—and almost half of the rice varieties. Some universities have also registered varieties of rice, beans and *semi-maíz duro*. Private companies, for their part, focus more on cash crops such as *maíz duro* and rice. Many cultivars registered by private companies are imported, especially in the case of *maíz duro*. However, according to our interviews, some companies also have breeding programs.

In the following, we discuss the breeding objectives and germplasm sources used in crop improvement programs for our key crops.

Maize: INIAP has developed maize varieties for both the Sierra and the Coast. In the Sierra, the first varieties were released in the 1970s and 1980s, based on genetic pools generated by CIMMYT. From the 1990s onwards, the focus shifted to working with native materials, such as *Maíz negro*, *Mishka*, *Canguil*, *Chulpi* and *Morochillo* (Zambrano et al., 2021; Zambrano Mendoza et al., 2021), using germplasm from the National Genebank and also from field collecting missions. The objective of this work has been to contribute to the conservation of native maize, while improving certain traits to support wider use of the varieties. For example, in Cotacachi, INIAP's maize program supported DENAREF and the CBDAs in the selection of *Canguil rojo* (a native variety of popcorn with red kernels) to improve popping rate. The resulting material was then multiplied and distributed to the communities. In another initiative in the Puyo area, the program is working on improvement of *Tusilla* maize together with the Shuar people,

Table 12. Number of cultivars registered in Ecuador for key crops. Source: http://geoportal.agricultura.gob.ec/index.php/mapas-interactivos/catalogo-semillas. Download date: 19 October 2023.

Crop	No. of cultivars registered	No. registered by INIAP		No. registered by other entities	
		No.	%	*Public*	*Private*
Rice	43	19	44%	Universidad de Guayaquil (2)	Pronaca (7), UPL Ecuador (6), Interoc (6), Agripac (2), Comercializadora Ecuatoriana (1)
Maíz suave	18	18	100%	n/a	n/a
Sweet maize	4	1	25%	n/a	UPL Ecuador (2), Alaska (1)
Maíz duro	180	24	13%	n/a	26 companies; those with the most registrations are: Agripac (21), Interoc (19), Dupont (14), Bayer (12), UPL Ecuador (11)
Semi-maíz duro	1	0	0%	Universidad Central (1)	n/a
Potato	25	24	96%	n/a	Pepsi Co. (1)
Common bean	28	25	89%	Universidad Estatal de Bolivar (1)	Carmen Elena Cornejo Mignone (2)
Fava bean	5	3	60%	n/a	Agrosemillas (1), Carmen Elena Cornejo Mignone (1)
Pea	7	5	71%	n/a	Bayer (1), Alejandro Capelo Importaciones y Comercialización (1)

following their indigenous worldview and management practices throughout the process. There has also been work to promote agro-industrial uses. One success in this respect has been the variety INIAP-199 Racimo de uva, a black maize selected from among 65 materials conserved in the National Genebank (Yánez G. et al., 2016). Although there are no studies confirming the level of adoption of INIAP-199, the program considers that the expansion of sales of purple maize beverages in recent years may be attributed to the launch of the variety in 2017. Recently, INIAP has also started a pilot project for developing *choclo*-type hybrids for the Sierra to try to increase yields, which has been a limitation to date in breeding with native germplasm. The Pontificia Universidad Católica del Ecuador has developed varieties of *Morocho* maize and *maíz suave* for the Sierra, but these varieties have not been formally registered and released; instead, they were returned to the farming communities.

Potato: INIAP's potato program started in 1969 and has registered a total of 24 varieties. Like the maize program, it first began working with imported materials and later focused more on Ecuadorian germplasm. Early objectives were to improve disease resistance and yields; subsequently, breeding targeted climate-stress tolerance, biofortification, and specific niche markets. For example, the varieties *Yana shungo* and *Puca shungo* were developed in response to a request from a company that exported coloured potato chips; these were produced from native varieties, but they needed earlier and disease-resistant materials to reduce the use of agrochemicals. This grew out of an initiative that used the "participatory market chain approach" to link potato producers, market actors and agricultural service providers to identify market opportunities (Devaux & Ordinola, 2019). The potato program has also worked with a nutritional focus to breed biofortified varieties such as INIAP-CIP Libertad. This variety was developed in collaboration with CIP, using germplasm high in iron, zinc and vitamin content from CIP's genebank in Peru. Although most of the varieties produced by the program are oriented towards commercial uses, some, like INIAP Natividad, have traits that are appreciated for home-consumption. The program has also registered some potato varieties developed by other breeders, such as Superchola, which was generated by Germán Bastidas, a self-taught researcher who bred many varieties across different crops throughout his life.[15]

Legumes: Initially established as two separate programs, INIAP now has a single program covering both legumes (common bean, fava bean, pea and *chocho*) and Andean grains (quinoa and amaranth). Breeding activities began in the 1980s, working mainly with Ecuadorian germplasm. Between 1995 and 2013, the program participated actively in an international research network that helped to release more than 20 common bean varieties—both bush and climbing types—of different colours and with tolerance to various diseases. Five varieties of pea and three varieties of fava bean have also been released. In the last five years, the program has focused more on *chocho* and quinoa, and, to a lesser extent, fava bean. This is partly due to growing international market interest in the nutritional qualities of Andean grains, which in turn opens up more funding opportunities. Moreover, the program does not have sufficient human and financial resources to work intensively on all crops. Although no common bean varieties have been released since 2015, some of INIAP's varieties remain valued by farmers—as seen in Cotacachi, where varieties such as Centenario and Canario are grown mainly for their market value. Apart from INIAP, the Universidad Estatal de Bolívar released a climbing variety called Bombolín, also in 2015.

Rice: INIAP's rice program has been operational since 1970 and has released 19 varieties. Initially, the program sought to develop varieties with higher yields and shorter cycles than the *criollo* varieties that were mostly grown at the time. INIAP-11, released in 1989, was the first short cycle variety (105 days), which allowed some producers to achieve up to 3 harvests per year. Together with other varieties such as INIAP-14

15 https://manueljbastidas.blogspot.com/2011/01/el-padre-de-la-super-chola-un.html

and INIAP-15, it continues to be appreciated by farmers due to its agronomic characteristics, as seen in Daule. From the 2000s onwards, Ecuador began to achieve self-sufficiency in rice production, and INIAP started to focus more on the quality attributes demanded by the industry, which remains the rice program's main objective today. The latest varieties released have been oriented towards different markets: INIAP-FL Élite has cooking qualities suitable for markets in the Sierra, while INIAP-Impacto has qualities preferred by consumers on the Coast. The program is also working with *japonica* materials with high starch content, to develop varieties for niche markets such as rice-based *chicha* (a traditional rice beverage) and consumers of Asian descent. Initially, the program worked with germplasm from the International Rice Research Institute in the Philippines. Since 2010, however, the main source has been the Latin American Fund for Irrigated Rice (FLAR), an alliance that facilitates access to advanced lines developed from materials held by the International Centre for Tropical Agriculture (CIAT).[16] The use of FLAR lines greatly shortens the breeding process, allowing researchers to focus on selection and evaluation. The program rarely uses germplasm from DENAREF, since the national genebank mostly conserves *criollo* materials.

In addition to INIAP, we identified two private companies with active rice breeding programs. Interoc, which has its own genebank, has developed four varieties, aiming to increase yields and meet grain-quality criteria required by the rice industry. Its most recent variety, Boreal, was registered in 2022. Agripac has also recently initiated a breeding program, working mainly with FLAR materials. It has not yet released its own variety but aims to develop varieties for different rice-growing areas, seeing a need for new materials due to climate instability and increasing problems with pests and diseases. It is noteworthy that Agripac is the company that produces the varieties SFL-09 and SFL-011. These materials were developed by FLAR and introduced into Ecuador by the company Pronaca in 2009 and 2011 respectively. This was done with support from INIAP, which carried out the field trials. Agripac acquired these two varieties when Pronaca sold its seed business (a company named INDIA). Among universities, the Universidad de Guayaquil registered two rice varieties in 2014—Vinces UG-03 and Vinces UG-10—which are derived from *criollo* materials (Painii-Montero et al., 2018). The Universidad de Babahoyo is developing rice varieties for saline soils based on interspecific crosses between wild and *japonica* types (Cobos Mora et al., 2022).

Intellectual property and farmers' rights

Ecuadorian legislation grants specific rights to both farmers and breeders, which are important aspects of seed system governance. Under the international agreements to which Ecuador is a signatory (the UPOV 1978 Convention and Andean Decision 391), implemented through the Organic Code of the Social Economy of Knowledge, Creativity and Innovation (COESI) (República del Ecuador, 2016), persons who develop varieties that are "new, distinct, uniform and stable" may apply for plant breeders' rights, which confer intellectual property protection as compensation for the investment made in breeding. Protection is given for a period of 15 years for annual crops, during which third parties cannot reproduce, propagate or multiply the variety without the breeder's consent. In principle, this protection is available for materials developed using any breeding method, including "experimentation and observation by farmers" (COESI, Art. 472). However, it is unlikely that farmers would meet the formal requirements (Jefferson, 2020). In practice, most registered plant breeders' rights in the country are for ornamental plants, mostly by international companies, although there are also some registrations for food crops by both public and private institutions. Since 2013, it has been INIAP policy to protect its varieties to generate income through royalties. According to INIAP data, the Institute holds protection for 33 varieties of 14 species, including 7 rice varieties, 5 maize varieties (mostly *maíz duro*), 3 potato varieties and 2 common bean

16 https://flar.org/mejoramiento-genetico

varieties. Although we do not have precise figures, private companies also apply for plant breeder rights for crops such as rice and *maíz duro*. However, not all private-company varieties are protected: for example, the rice varieties SFL-011 and SFL-09 do not have registered plant breeders' rights in Ecuador.[17]

The UPOV Convention, both in its 1978 and 1991 versions, recognizes exceptions to plant breeders' rights, allowing protected varieties to be used for private, non-commercial purposes and for research. COESI incorporates these exceptions, but also states in Article 489 that protected varieties can be used "in the context of ancestral farming practices or in a traditional farming community setting, including for sale or exchange on a non-profit basis" (Jefferson, 2020; República del Ecuador, 2016). The LOASFAS further recognizes farmers' rights, including the right to "produce, conserve, exchange and access all types of seed—native, traditional and certified" (Art. 8). In effect, this means that plant breeders' rights do not limit smallholder seed production, and even protected varieties can circulate freely within the informal seed system.

4.2 Seed production

Multiple actors are involved in the production and storage of different categories of seed. The LOASFAS defines two main types of seed: *semilla campesina* (farmer-managed seed), produced within the informal (or "non-conventional") system, and certified seed, produced within the formal (or "conventional") system that is subject to regulation by the State. At the national level, certified seed is used on only 31% of the area planted with annual crops (ESPAC, 2022), and most of this corresponds to *maíz duro* (Table 13). *Semilla campesina* therefore predominates, as is clearly seen in both Cotacachi and Daule. A "mixed system" has also emerged, which functions as an intermediate system combining elements of both informal and formal seed systems (Kromann et al., 2016; Mazón et al., 2019; Peralta I. et al., 2009) and resembles the FAO's Quality Declared Seed system (FAO, 2006). Below, we analyze the production of *semilla campesina*, certified seed, and seed from the mixed system.

Semilla campesina

The main actors in the production of *semilla campesina* are, of course, the farmers themselves. However, in this study we distinguish two modes of seed production. The first is farmers who save seed from their harvest and store it for use in the next cropping cycle. This predominates in Cotacachi and allows families to produce and access seed for a wide diversity of crops and varieties. Although farmers generally have considerable trust in their own seed, they also recognize challenges related to pests and diseases that affect seed, especially during storage of maize and potato. Seed management practices vary among farmers with consequences for the incidence of seed-borne pests and diseases, especially in vegetatively propagated crops such as potato (Almekinders et al., 2019; Navarrete et al., 2022). In Cotacachi, DENAREF and CBDAs' seed multiplication and restitution activities have included training participating farmers in seed production, but in general farmers indicate that they receive little support to improve their seed production. In the main potato-growing districts of the Sierra, INIAP and CIP have supported farmers in potato seed production, promoting, for example, positive selection in the field and periodic seed renewal, among others (Fabián Montesdeoca et al., 2012). The Red de Guardianes de Semillas also offers training to some of its members on organic vegetable seed production. MAG's support for family and small-scale agriculture, meanwhile, has focused more on promoting the conservation and use of native seed (see above) than on techniques to improve seed production *per se*.

A second, particularly interesting, mode of production of *semilla campesina* consists of farmers who specialize in producing seed specifically to sell to other farmers. In Daule, these local seed producers (*productores de semilla artesanal*) play an important—but perhaps under-recognized—role in the seed system. We did not find references to this phenomenon in the literature

17 Source: Certificate of search issued by SENADI, 12 August 2024.

on Ecuador's rice seed system. However, in a detailed study of the rice sector in Ecuador between 2014 and 2019, Marín et al. (2021) report that in Guayas and El Oro, "92% of the producers who used recycled seed obtained it from other farmers in their community", confirming that the vast majority of farmers are not producing their own seed. Although we only have data from four communities, our results suggest that much of this recycled seed likely comes from local seed producers who specialize in this activity. Although less common, we also identified the existence of local seed producers in more commercially oriented communities in Cotacachi, who sell seed of *Maíz leche* (see Section 3.2).

What distinguishes the local seed producers from the seed-saving practiced by most farmers is that they allocate a separate plot of land for seed. As a local seed producer in Daule explained: "I plant three lots, each one a *cuadra*: two lots are for rice to sell to the *piladora* and one lot or one *cuadra* I leave for seed to sell" (DL-KII-01, Pos. 62). The local seed producers we interviewed described various practices they use to maintain seed quality, such as using certified seed as starting material for each cycle, carrying out germination tests, levelling the soil well, raising seedlings and sowing by transplanting so that weeds can be easily identified and removed, following an appropriate fertilisation and pest management regime, and thoroughly cleaning the seed drying area, among other practices. At the same time, both the local seed producers we interviewed, and the focus groups, noted that there are also some local seed producers selling low-quality seed. One local seed producer explained: "They put it up for sale, but it isn't good seed—it has been recycled three or even four times. In my case, to produce *semilla artesanal* I buy certified seed [to multiply]; in the next harvest I buy certified seed again so that my *semilla artesanal* is first class" (DL-KII-01, Pos. 68). Generally, social ties and norms are important in informal seed systems, and farmers tend to rely on seed sources they trust (Coomes et al., 2015). However, according to our interviews, increasingly more producers are entering the local seed business, with increased competition driving some to produce the cheapest seed possible. In this sense, there is a need for some form of quality-assurance system for local seed producers' *semilla artesanal.*

The local seed producers we interviewed work independently, without support from any project or government agency. In Daule, initiatives supporting farmers in seed production fall more within certified-seed production. For example, CESA works with groups of farmers to produce certified seed, offering technical support throughout the process. Private companies also provide training in seed production to outgrowers, as well as to farmers who raise seedlings for the companies. Although these supports allow farmers to learn techniques that can be applied to the production of *semilla artesanal*, this is not an explicit objective. Nevertheless, INIAP's Portoviejo Experimental Station has published a guide for the "artisanal production of rice seed" (Carrillo Alvarado et al., 2011).

Although the LOASFAS aims to "implement programs for the promotion and strengthening of seed production" (Art. 6g) and assigns MAG responsibility to "establish mechanisms for benefits and incentives for the production of native, traditional and certified seed" (Art. 13b), the chapter on *semilla campesina* places greater emphasis on farmers' rights to exchange seed freely and on preventing the misappropriation of native seed. Apart from Article 24 for the development of participatory quality-control processes (see section below on mixed systems), there are no provisions in the law to improve the quality of *semilla campesina*. According to a MAG representative, even if the law guarantees farmers' right to save, produce, and exchange their seed, supporting the production of *semilla campesina* is not a strategic objective:

> What the law says is that there is *libre circulación* (free exchange)—that is, there is no regulation over it [*semilla campesina*], it is not restricted but simply allowed to flow. It should be encouraged, but there is no assistance in that aspect, because if you are only recycling the seed, you will not reach a successful point in the future [...] you can organize fairs, promote production, storage, and exchange, but nothing beyond that (EC-KII-15, Pos. 120).

From this perspective, the State's priority for ensuring access to quality seed continues to be the production and dissemination of certified seed.

Certified seed

Certified seed is produced according to the regulations and standards set by the State. The main objective is to ensure that seed is produced under defined quality standards, thereby providing a guarantee to farmers. The regulatory framework is set out in the LOASFAS, its implementing regulation, and the technical standards for seed certification established for each specific crop (República del Ecuador, 2017, 2020).

The certification process includes the production of different seed categories (breeder, basic, registered, and certified), each of which must meet specific standards. Certified seed can only be produced for cultivars registered in the *Registro Nacional de Cultivares* (national catalogue). MAG is responsible for quality control of the different seed categories. The process includes registration of the seed-production area; field inspections at several stages in the crop cycle (pre-sowing, standing crop, and post-harvest); and laboratory analysis of seed samples by Agrocalidad (the national authority for plant and animal health and seed/food safety control). If all the criteria set out in the crop technical standard are met, MAG issues tags (*marbetes*) that are attached or sewn onto the seed packaging. Currently, tags are issued for 14 crops: *maíz duro*, *maíz suave*, rice, potato, common bean, pea, *chocho*, quinoa, amaranth, wheat, barley, oats, soybean and peanut.

To produce certified seed (or any other seed category), an entity must be accredited by MAG for the specific crop and category to be produced. In MAG's registry of seed producers there are more than 150 accredited entities, including private companies, public institutions (such as universities and INIAP), producer associations, local governments, and individuals. However, many are not actively producing certified seed. For crops such as rice and *maíz duro*, private companies are the main producers, although in the case of rice, producer groups supported by CESA also contribute. For other crops, INIAP, producer associations, and individual farmers play a more important role (Table 13).

A seed inspector from Guayas observed, however, that the certification process is too demanding for many smaller actors who lack institutional backing:

> At one point, we worked with ordinary producers—that is, natural persons [individual farmers]—for seed production. But unfortunately, they threw in the towel, as we say. They thought that handling seed is the same as managing a conventional crop, when it is not; the care required is different. So, when you start tightening the requirements and telling them, 'This is not the way to do it', they say 'No, that's it, I'm done', because they also need to have a market where they can sell it. [...] Perhaps [they could succeed] with support from an institution that really wanted to help them, providing assistance throughout the process, from crop establishment to market access (DL-KII-08, Pos. 100).

INIAP does not play a major role in certified seed production since, under the law, it is assigned the responsibility for producing the early generation seed categories (breeder, basic, and registered). INIAP may request special authorization from MAG to produce certified seed, but its focus is on producing early generation seed of its own varieties, as well as certain public-domain varieties. For varieties registered by private companies or other entities, these actors either produce their own early generation seed or license another producer to do so. For example, Agripac produces all categories of SFL-09 and SFL-011 seed, from breeder to certified, working through contracts with outgrowers.

Interviews revealed several challenges related to certified-seed production. On one hand, some interviewees mentioned weaknesses in the technical standards for the certification of certain crops. For example, the potato standard does not take into account purple top, despite the fact that this disease has affected Ecuadorian farmers since 2015 (Navarrete et al., 2023). In rice, informants noted that Ecuador's certification standards are stricter than in other rice-producing countries, making certified-seed

production more costly. For example, according to one interviewee, the Ecuadorian standard requires higher germination rates than in other countries, which leads to losses. Seed inspectors also noted that some protocols still need to be developed in greater detail.

On the other hand, it is difficult to estimate demand for seed, which varies from year to year, due to factors such as fluctuations in sale prices and subsidy policies. At INIAP, production planning is based on requests that MAG receives once a year from seed producers and transmits to INIAP. INIAP then signs a contract with the seed producers, specifying the quantity of seed to be produced and, in the case of protected varieties, the royalty to be paid to INIAP per tonne of seed marketed. This system is intended to ensure that all those actors wishing to buy early generation seed can submit their requests, and to guarantee that seed produced by INIAP will be purchased. However, according to interviews, some producers do not place their requests formally, but instead contact INIAP directly, which sometimes results in unsold seed. Moreover, for certain actors the process for submitting seed requests is impractical and the varieties available are too limited, as an NGO representative explained:

> So, if you want to implement a project—for example providing starter material to producers so that they can multiply a certain variety, you are limited to two [potato] varieties. And if you want more varieties you need to notify them [INIAP] two years in advance so that they can produce the other varieties. So that is the problem (EC-KII-17, Pos. 66).

As this quote indicates, the diversity of varieties produced within the formal system is limited, partly due to market forces. For example, in potato, Superchola accounted for more than 80% of the potato seed produced by INIAP in 2022, as it is the variety most in demand nationally: "We have a hegemonic variety here in this country, which is Superchola, and in reality no one has been able to replace it" (EC-KII-02, Pos. 85). According to one interviewee, Superchola has become almost a "paradigm":

> It's like the mineral water here, […] we have one called Güitig. So, there are several brands, but when you go to the shop people say, 'give me a Güitig', they don't say 'give me a mineral water'. It's the same with Superchola among potato growers and consumers. On the Coast they'll buy any variety—if it's red, they call it Superchola and people buy it, because they don't really distinguish among varieties. In the Sierra they know: if you offer them a red potato as Superchola they say no, 'this is not Superchola' (EC-KII-09, Pos. 96).

Similarly in rice, SFL-011 has dominated since 2017, replacing other popular varieties such as INIAP-14 and SFL-09 (Marín et al., 2021), as it is preferred in the Sierra for its cooking qualities. A *piladora* we interviewed explained that the wholesalers they supply specifically request this variety. Some consider this to be the result of strong promotion by Pronaca—the company that introduced SFL-011 into Ecuador—and its substantial influence in the sector. Others highlight factors related to the milling process that favour this variety. For example, one interviewee explained that milling equipment was modernized from 2015 onwards, which increased the milling yield of SFL-011, and contributed to the variety's boom. Another informant noted that many *piladoras* have their equipment calibrated for SFL-011, and do not want to process other varieties such as Impacto because they require different calibrations. This dynamic presents challenges for seed producers working with other varieties, such as CESA, which produces INIAP varieties. They now work with only 10–20 farmers, compared to 100 in the past, and have not certified their seed because the demand does not justify the cost. To keep INIAP's varieties on the market, the institute has produced limited quantities of certified seed of certain varieties (INIAP FL-Arenillas, INIAP FL-1480 Cristalino, INIAP-Impacto, and INIAP FL-Élite). INIAP is also implementing a strategy to grant companies an exclusive licence to produce the registered seed category for a given variety; one such agreement has now been signed for a new INIAP variety that is about to be released.

Table 13. Percentage land area planted with certified seed, number of accredited seed producers, and volume of certified seed produced in 2022 for key crops.

Crop	% of land area planted with certified seed*	No. of certified-seed producers**		Certified seed produced (kg)**				
		Accredited	Producing in 2022	Private company	INIAP	Producer associations	Natural persons	Total
Rice	16.6%	33	6	726,655 (75.1%)	44,183 (4.6%)	180,000 (19%)	12,465 (1.3%)	950,838
Maíz duro §	57.0%	24 §	15	5,087,946 (99.6%)	15,553 (0.3%)	0	4,080 (0.1%)	5,107,579
Maíz suave	0.5%	44 §	1	0	540 (100%)	0	0	540
Potato	12.6%	58	7	33,075 (11.6%)	52,155 (18.4%)	82,035 (28.9%)	116,820 (41.1%)	284,085
Common Bean	1.0%	13	1	0	270 (100%)	0	0	270
Fava bean	3.7%	7	0	0	0	0	0	0
Pea	1.2%	6	0	0	0	0	0	0

*Source: ESPAC, 2022. Estimates of land area include dry and fresh-grain production (maize, pulses) as well as monoculture and intercropped production.
**Source: Data submitted in 2023 by MAG's Dirección de Gestión de Recursos Agrícolas and INIAP's Dirección de Producción, Comercialización y Servicios Especializados.
§ In the MAG registry, entries sometimes appear simply as "maize", without specifying whether they are *maíz suave* or *maíz duro*. To estimate the number of seed producers for each maize type, we assumed that entities located on the Coast produced *maíz duro* and those in the Sierra produced *maíz suave*. However, some producers in the Sierra may produce *maíz duro*.

Mixed seed system

In the Sierra, the lack of private companies interested in producing certified seed is a major bottleneck to making INIAP varieties more widely available. One alternative strategy that has been developed in response to this situation is to support organized groups of *semilleristas* (seed producers) to produce and disseminate good quality seed in their localities, using a "mixed seed system" approach, which combines elements of the formal and informal systems (Mazón et al., 2019; F. Montesdeoca et al., 2012). Perhaps the most well-known case is that of CONPAPA, a consortium of three potato-producer organizations from the provinces of Tungurahua, Chimborazo and Bolívar, which has developed an initiative to produce good quality potato seed tubers. With technical support from INIAP and CIP, members of the organization were trained in quality seed production, and an "internal quality-control" system for seed was developed and implemented, in which members of the organization are trained to carry out inspections. These include field inspections, but with a simpler protocol than that used for certified seed. The seed produced carries a minimum quality guarantee, and a distinctive label is applied to indicate that it passed internal control (F. Montesdeoca et al., 2012; Montesdeoca et al., 2013). This experience has also motivated similar initiatives for amaranth, quinoa and bean (Mazón et al., 2019; Peralta I. et al., 2009).

In 2015, elements of CONPAPA's internal-control protocol were integrated into the technical standard

for potato seed certification, in the seed category *semilla común* (ordinary seed) which existed at that time. This approach is similar in principle to FAO's Quality Declared Seed system (Kromann et al., 2016; República del Ecuador, 2015). Article 24 of the LOASFAS states that traditional seed producer organizations, as well as other natural persons and legal entities, "may establish participatory processes and mechanisms for internal regulation, in accordance with the technical criteria established for this purpose by the National Agrarian Authority". However, these criteria have not yet been developed, and the revised potato standard of 2021 focuses solely on certified seed.

4.3 Seed dissemination

Seed dissemination refers to the processes that allow farmers to access seed and the related knowledge or information, such as variety characteristics, planting techniques, etc. A range of actors are involved in seed dissemination, including farmers, informal traders, private companies, agro-dealers, CBDAs, NGOs, and agricultural development programs, among others.

Farmers disseminate a diversity of seeds through social relationships, whether with relatives or neighbours, as well as through social networks, where "word gets around" about who has seed—even in the most remote areas. Sometimes they take advantage of periods of seasonal or temporary work away from home, or other travel, to bring back seed. Local seed producers mostly sell *semilla artesanal* to people they know in their own locality or neighbouring areas, making use of their social networks. Producer associations, such as CONPAPA, also sell seed mainly to their members and other local farmers, although they sometimes achieve broader reach by selling to NGOs and institutional buyers (Buddenhagen et al., 2017; Kromann et al., 2016; Mazón et al., 2019). The internal quality control system helps reduce production costs compared to certified seed, and therefore the seed from the "mixed seed system" is sold at more accessible prices (Kromann et al., 2016).

Several actors promote seed exchange among farmers as a strategy to support the conservation and use of agrobiodiversity. Seed fairs are among the most mentioned mechanisms in the interviews, and *ferias libres*[18] and other venues for exchange and commercialization are recognized in LOASFAS Article 29 as a strategy that MAG, local governments and community organizations must promote to "guarantee free access, exchange and commercialization of native seeds". We have no data on the number or distribution of these fairs across the country. Our results from Cotacachi suggest that fairs are a complementary, though less important, seed source than social networks. According to UNORCAC, each year the *Muyu Raymi* Seed Fair attracts around 400 farmers (mostly women) who exhibit their seeds and 5,000 visitors. The fair also includes demonstrations of local gastronomy, traditional medicine and local products (Piñán Cajas, 2023). In this sense, the fair serves not only as a space to exchange seeds, but also to promote and educate about agrobiodiversity and related practices. Another dissemination strategy in Cotacachi is the distribution of seed "kits" produced as part of the restitution initiatives. This is done mainly in the context of projects run by UNORCAC, DENAREF and the CBDAs. UNORCAC notes that both the Seed Fair—which is already a large event—and the distribution of the kits require external support. A representative of UTN's CBDA notes that they lack mechanisms and capacity to disseminate seed on a more continuous basis:

> I need to start disseminating the activities we carry out at the CBDA. Just like the seed savers' networks do, we have to let people know what seeds we have, when they are available, and distribute them. But that requires having someone dedicated to media and communications, because with everything else that I'm doing, I can't keep up, and my colleagues are in the same or worse situation. So, it's difficult because we're missing that part, the daily communication and outreach (CO-KII-04, Pos. 125).

18 Ferias libres (literally, "free fairs") can be understood as community-run fairs that are not regulated by the State. As discussed in the Seed Governance section, "free" in this context refers to farmers' right to exchange seed.

UTN also mentions that another barrier is that access conditions do not permit the CBDAs to disseminate DENAREF materials kept as duplicates in CBDAs. According to DENAREF, this would require establishing a separate agreement between INIAP and the farmers, whereas no such agreement is required for agrobiodiversity that the CBDAs have obtained directly from farmers.

The Red de Guardianes de Semillas—a network of about 150 producers in 17 provinces involved in permaculture—exchanges native and *criollo* seeds at in-person events as well as remotely, using social media platforms such as WhatsApp and courier services. As one representative explains: "There's a huge amount of seed exchange in the Network; someone may have lost a variety they once had, so they ask within the Network and find someone else who has it—so that's the dynamic" (EC-KII-04, Pos. 97). They estimate that around 4,000 varieties circulate through the Network using these mechanisms. They also tried to set up an enterprise to sell organic seed using a participatory guarantee system, but the high costs of agroecological production made it difficult to compete with imported vegetable seeds.

With respect to certified seed, dissemination takes place through authorized sales points that must be registered by MAG. Some private companies have their own sales outlets where they sell their own products—for example, Agripac has 212 outlets nationwide. Others distribute their seed through agro-dealers, who sell a range of agricultural inputs from different suppliers. Smaller seed producers, such as CESA, sell seed directly from their own premises. INIAP uses a similar strategy: when certified seed is available, the institute announces it through its social media channels so that interested buyers can come to the Experimental Stations to purchase it. Both CESA and INIAP sell certified seed at a more affordable price than private companies,[19] but they serve a more specific clientele. A technician from INIAP's Litoral Sur Experimental Station explained:

> In years like this, which are a bit challenging because of the climate, we have tolerant varieties that still produce well—like Arenillas or Cristalino—we've sold Arenillas well because producers say, 'I don't want to take risks'. […] This year we had a producer who also has his own *piladora*, and he said that this year he would focus exclusively on Arenillas. […] Producers who have their own milling operations know how to navigate the market (DL-KII-07, Pos. 130).

In the Sierra, where demand for certified seed is low, INIAP is experimenting with new strategies to disseminate seed through the informal system. This is being tested, for example, in a FIASA project in which INIAP varieties are being disseminated through farmer groups, combined with training in seed production, crop management, nutrition, and agribusiness. Several INIAP interviewees noted that the institute lacks a marketing and dissemination strategy.

MAG controls the commercialization of certified seed through unannounced inspections at points of sale, and through controls on import and export. In Guayas, the most frequent infractions involve *maíz duro* and include the sale of counterfeit seed (recycled seed without a tag), expired tags, and repackaged seed (opened bags sold by the pound). Several interviewees consider this a serious issue because it creates mistrust in the formal system among farmers. There are also problems with illegal seed imports. In rice, for example, the varieties Valor and Ferón were introduced from neighbouring countries (Colombia and Peru) without being duly registered in Ecuador, and as a result, circulate only within the informal system. According to one interviewee, MAG has recently adjusted the regulations to improve the identification of cultivars and the issuance of tags for imported seed.

19 INIAP sells certified rice seed at USD 54.90 for a 45 kg bag. According to the focus groups, CESA charges around USD 40-45, while private companies sell for USD 70-75.

The purpose of seed dissemination is to enable farmers to access the seeds they need and want. Important factors influencing farmers' access to seed include access to information about the variety, where to obtain the seed, and how to manage it, as well as access to the economic or social means to acquire it (CGIAR, 2016; FAO, 2016a). In Cotacachi, we identified few problems with seed access: in the focus groups, participants felt that they can obtain seed from social networks, fairs, local shops, and other sources when needed. However, there are information-related challenges, particularly regarding the adaptability of seed obtained from external sources. In Daule, the main barrier to access is the lack of economic resources to purchase certified seed. In what follows, we discuss initiatives by various actors to improve seed access across these different dimensions.

Economic access

The high cost of certified seed was mentioned in the focus groups and in many interviews as an important barrier for small-scale farmers. Initiatives involving seed producer groups—such as CONPAPA and CESA—offer an alternative for providing good quality seed at a more accessible price. However, at the State level, the main strategies for facilitating economic access to quality seed (and other inputs) have focused largely on subsidies and financial instruments.

One strategy has been subsidies in the form of technological packages or "kits", which MAG has implemented since 2012 through various projects commonly known under the name *Plan Semillas*.[20] The main objective has been to increase productivity and technology transfer to compete with the lower prices of neighbouring countries. In the first ten years of the program, the focus was on *maíz duro* and rice, but since 2023 it has shifted toward fruit crops and export products such as cacao, bananas and coffee. Private companies propose which inputs to include in the packages for each canton, and these are evaluated by MAG. Sometimes the packages only include agrochemicals, especially when seed availability is low. This is the case for potato, where subsidies are currently available only for phytosanitary control of purple top disease, as well as for crops such as cacao, bananas, and coffee. The reduced emphasis on seed for these crops is reflected in the current name of the program which translates as National Productive Incentives Project for the Agricultural Sector (PNIPSA). The project also includes an information dissemination component, in which the companies organize learning events and demonstration plots to showcase the varieties and inputs included in the packages. Farmers—who must be registered in the MAG's National Registry of Farmers to access the program—can choose the package they want from the options offered in each locality. Companies coordinate the delivery of the packages at their sales points.

For rice, between 2016 and 2023, the program provided subsidies for 126,710 technological packages, with a total value of USD 28,514,490,[21] reaching about 40% of rice producers (Marín et al., 2021). During this period, approximately 69% of the subsidized rice packages included seed. This program influenced the market, creating a "boom" in demand for certified seed. For example, between 2016 and 2018, INIAP had to reorganize its production of early generation seed to meet demand, and farmers recall times of seed shortages in the commercial outlets. Seed of 17 rice varieties was distributed through the technological packages, but five varieties account for more than 85% of the subsidies (Figure 3). The data reflect general trends in the rice market, showing increased dissemination of the variety SFL-011 from 2018 onwards, and reduced dissemination of varieties such as INIAP-14 and INIAP FL-1480 Cristalino. Notably, the kits distributed seed of INIAP-11 as recently as 2022, even though INIAP has not produced registered seed of this variety since 2016.

20 *Plan Semillas* was a pilot conducted in 2012–2013. The initiative was later implemented as a national project under several names: Proyecto Nacional de Semillas para Agrocadenas Estratégicas (PNSAE) from 2014 to 2022, and *Proyecto Nacional de Incentivos Productivos para el Sector Agrícola (PNIPSA)* since 2023.

21 Data provided by PNIPSA, 16 November 2023.

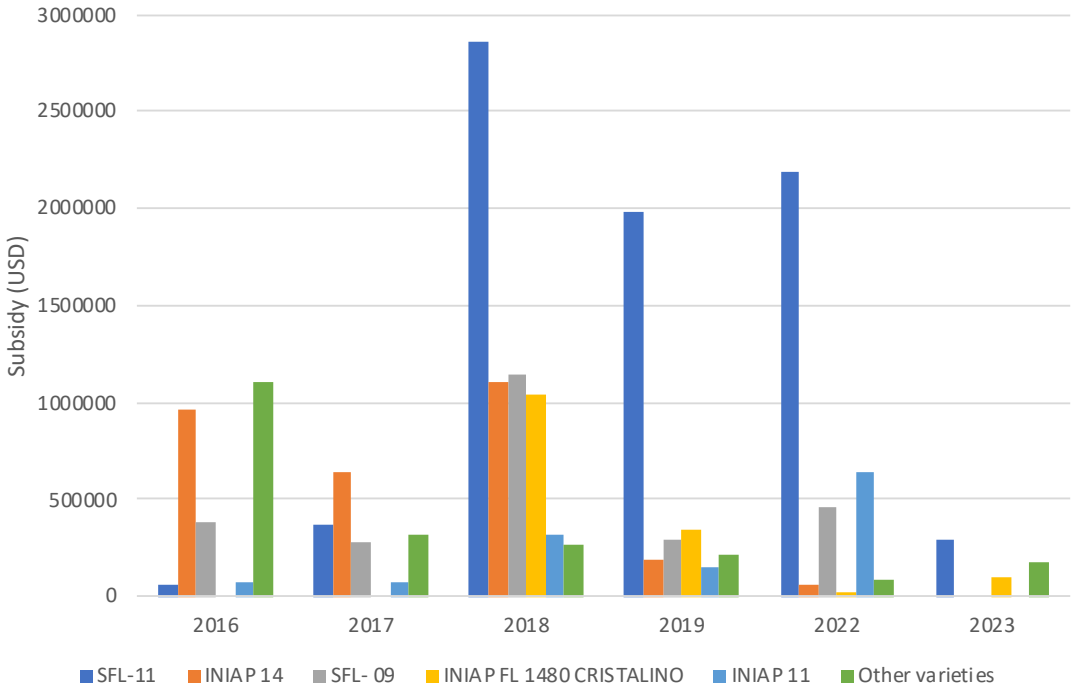

Figure 3. Value of subsidies granted between 2016 and 2023, for technological packages with the five most important rice varieties. Only packages that included seed are presented here. No packages were delivered in 2020 and 2021 due to the COVID-19 pandemic. Source: Data provided by PNIPSA, 16 November 2023.

From 2023, PNIPSA has focused on crops other than maize and rice, based on the expectation that higher yields obtained through the technological packages will encourage farmers to continue purchasing inputs with their own resources: "Now we hope to shift this toward commercialization—that the buyer respects the standardized prices and that it is the farmer who purchases the product." (EC-KII-12, Pos. 93). However, our findings from Daule suggest that many rice farmers stop using certified seed when the subsidy is withdrawn.

Other strategies to facilitate access to inputs include agricultural insurance and credit programs. At the State level, the program CampoSeguro offers premium subsidies of 60% to small and medium-scale farmers to protect their investments against climatic events and uncontrollable pests and diseases, while BanEcuador offers loans of up to USD 10,000 to small and medium-scale farmers for the purchase of inputs.[22] In collaboration with the MAG, the Ministry of Industry and the Ministry of Production and of Social Inclusion, the "1x30" program offers loans of up to USD 5,000 to small-scale producers and entrepreneurs with 1% interest over 30 years.[23] Other sources of credit include private banks, cooperatives, and savings and loan groups. Some companies such as Agripac also offer credit to their customers. According to ESPAC (2022), at the national level, 20.5% of agricultural producers have *seguro campesino*[24] and only 4.2% have some

22 Datos obtenidoshttps://www.banecuador.fin.ec/2021/08/22/credito-para-la-compra-de-insumos-de-pequenos-y-medianos-productores-agropecuarios/

23 https://www.eluniverso.com/noticias/economia/los-requisitos-y-pasos-para-solicitar-el-credito-1x30-de-banecuador-nota/

24 In ESPAC, this refers to affiliation to the Seguro Social Campesino, a rural social-insurance regime administered by the Instituto Ecuatoriano de Seguridad Social (IESS), Ecuador's national social-security institution. It does not refer to CampoSeguro, the agricultural insurance program administered by MAG.

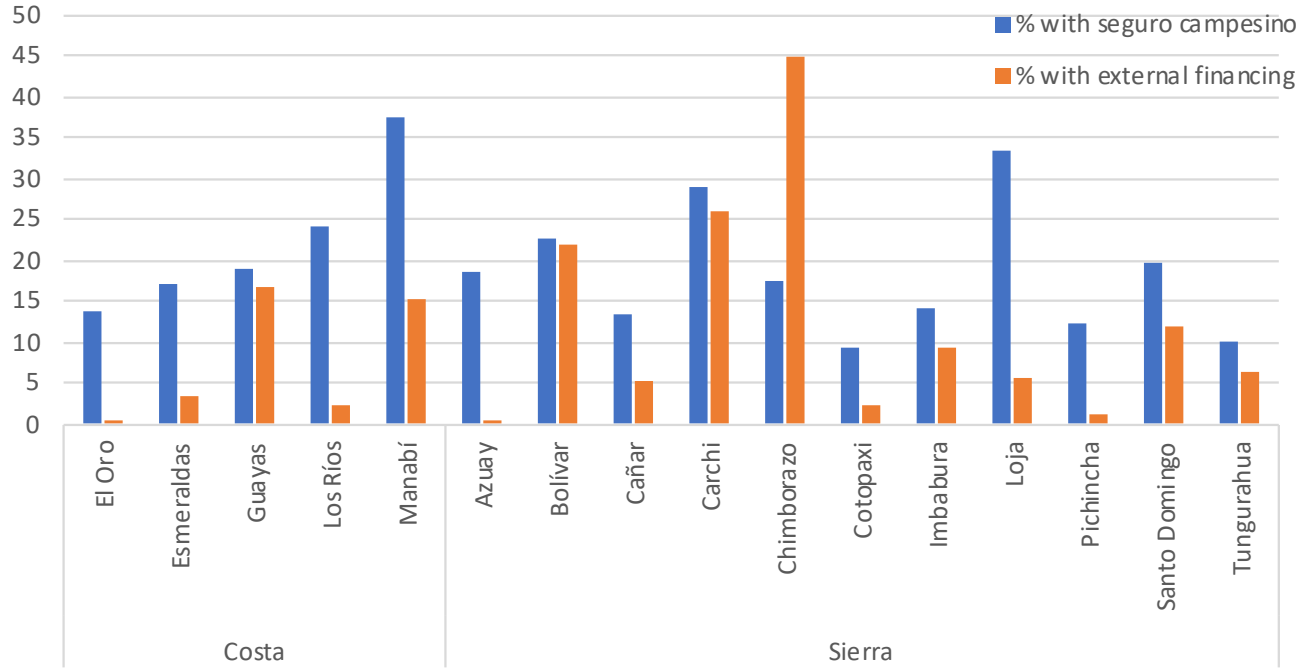

Figure 4. Percentage of agricultural producers with seguro campesino and external financing, by province, in the Coast and Sierra regions. Source: ESPAC 2022 Visualizer: https://www.ecuadorencifras.gob. Downloaded: 12 February 2024.

kind of external financing, mainly from private banks, although this varies greatly between provinces (Figure 4). It is likely that informal credit sources such as the *chulqueros* (illegal moneylenders) and *piladoras* used by smallholder farmers in Daule are not captured here (see Section 3.2).

Another strategy to improve farmers' purchasing power (and hence economic access) is to reduce production costs by promoting agroecological practices, such as the use of bio-inputs (Guzñay D., 2016; Rodríguez, 2016), varieties with greater resistance to pests and diseases, and practices such as crop or variety rotation. In rice, actors such as CESA argue that the indiscriminate use of agrochemicals is harmful not only for the environment but also economically for farmers, who might otherwise invest in good quality seed. According to CESA, they have seen positive results in a project with the municipality of Guayaquil:

> It's a one-year project where we train farmers to produce rice in a healthy way, using environmentally friendly practices, reducing their production costs without compromising their yields—making them profitable. For example, we obtained good results: they used to produce 7 tonnes per hectare, now they are producing 7.5 tonnes. Their production cost was USD 2,035 per hectare, now it costs them 1,400 dollars. [...] So, they have a more competitive product, it is more profitable, and most importantly, pesticide loads in the water were reduced (DL-KII-03, Pos. 52).

Some interviewees also suggest that the State should offer soil analysis services to improve the rational use of agrochemicals. As one producer explains: "We should have that here, but neither the government nor the municipalities have set up a laboratory so that people can do their soil analyses. And that's advisable—you know why? Because then you know what you need to apply and what disease your plot has." (DL-KII-01, Pos. 86).

Finally, several interviewees noted that the problem lies in the structure of value chains, which limits the prices farmers receive. Factors mentioned include farmers' dependence on intermediaries, the failure to enforce official prices established by MAG, and more generally

the lack of market outlets for many agrobiodiversity products. This limits farmers' purchasing power and their willingness to invest in "quality" seed—whether certified or from mixed systems. A MAG informant felt that much more work is needed across the entire chain to improve the returns that farmers obtain:

> There should be support and incentives in various areas, not only loans but also agricultural insurance and commercialization. Because many times, we've promoted production, but when the Ministry promotes it and there's more volume, prices drop and farmers don't want to do it again. So, what's missing is that linkage from production to securing a market, so they earn enough to stay in business. Otherwise, they do it once and stop—that's also a problem. (EC-KII-15, Item 146)

Access to information

It is important to recognize that farmers exchange knowledge and information about seeds through social networks, at fairs, during ceremonies and cultural practices such as *minga* (a traditional form of voluntary collective labour), and through initiatives such as seed savers' networks. Local seed producers and producer organizations are also sources of information about seeds and management practices. For example, in Tungurahua, CONPAPA plays a central role in disseminating both potato seed and information on pest and disease management among its members (Buddenhagen et al., 2017). These processes are affected by cultural and economic changes, particularly the migration of youth to urban areas, which is a central concern of organizations such as UNORCAC, and which various initiatives for the conservation and use of agrobiodiversity seek to address (see Section 4.1).

Actors such as INIAP and private companies that develop or introduce new varieties also have strategies to disseminate information to farmers about varieties and other technologies. In commercial farming areas such as Daule, private companies disseminate information about their products through posters and advertisements, as well as by organizing field days and distributing technical fact sheets. Interoc, for example, works with pilot farmers who test the varieties, and then share their experiences in informal gatherings with other farmers, traders and other stakeholders. Agripac also provides technical assistance through its website. Private companies usually focus on medium and large-scale farmers, who are the main market for certified seed. INIAP, for its part, has *núcleos de desarrollo tecnológico* (technology development units) in each of the Experimental Stations that work with groups of farmers to test and disseminate different technologies. They use the farmer field school approach, a collaborative learning methodology developed by FAO in the 1980s (FAO, 2016b), and promoted in the Andes by CIP. INIAP's technology transfer agents work with farmer groups to coordinate variety validation processes in the final stages of breeding, and then to promote wider dissemination. However, apart from Santa Catalina Station which has several decentralized technology development units, capacity at the other stations is relatively limited (Table 14). Capacity has also been reduced in recent years; according to one interviewee, in 2015–16 there were 70 technology transfer agents nationwide compared to only 22 at present. This is a significant bottleneck for the dissemination of INIAP's varieties. As a result, the institute is trying to strengthen linkages with rural extension initiatives run by MAG and local governments, providing, for example, training for MAG technicians in the farmer field school approach.

At MAG, technical assistance and rural extension services have been offered through different projects, the most recent being the Technical Assistance and Rural Extension Innovation Project (PIATER), implemented between 2022 and 2024.[25] PIATER is the country's leading extension program, with 1,318 rural extension

25 Since 2024, PIATER has been succeeded by the PIDARA project (*Proyecto Integral de Diversificación Agroproductiva y Reconversión Agrícola*). At the time the research for this report was conducted, PIATER was still in operation.

Table 14. Number of technicians associated with different rural agricultural extension and technology transfer programs. Sources: Data provided by the MAG and INIAP programs.

Institution - Project	No. of technicians	Comments
MAG - PIATER	1,318	PIATER represents 85% of rural extension workers in the country. They are distributed in all 24 provinces of the country and support various MAG projects.
MAG - AFC	40	At least 1 technician in each of the 24 district directorates of MAG.
MAG - PNIPSA	13	The 13 technicians cover all 24 provinces and have a coordinating role. They receive support from PIATER extension agents to disseminate technological packages on the ground.
INIAP - Technology Transfer Unit	22	There is a technology development unit in each of the 6 experimental stations, with 1 to 2 technology transfer agents per unit. In addition, there are 5 decentralized technology development units associated with the Santa Catalina Experimental Station.

agents spread across the 24 provinces. It is considered a transversal program within MAG and supports the implementation of projects such as PNIPSA and AFC initiatives, which have limited presence on the ground (Table 14). In 2023, technical assistance was provided to 164,284 producers, and trainings on various topics to 560,364 people, compared to an estimated 2.1 million people working in agriculture (ESPAC, 2019). Although agricultural technical assistance covered 143 crops, almost half of the assistance focused on *maíz duro*, cacao, and rice. Only 5% of agricultural technical assistance was directed toward family farming, although 36% of the training sessions addressed AFC-related topics.[26] According to data provided by PIATER, few of these supports (less than 1%) dealt specifically with seed-related issues, although this might be integrated more transversally. In PIATER, efforts are being made to incorporate several changes to improve planning and monitoring of the support provided, and to achieve greater impact. This includes, among other measures, introducing farmer field schools as the main methodology, with the aim of conducting participatory assessments with farmer groups and providing ongoing accompaniment, as opposed to sporadic technical assistance.

4.4 Seed governance

Seed governance refers to the formal and informal norms and rules used to coordinate and manage the seed system (Westengen et al., 2023). This is a complex topic, which we do not address comprehensively in this study. In the previous sections, we discussed several of the laws and regulations that shape the three seed system functions analyzed in this study. Here we discuss governance issues that affect the functioning of the seed system in a more cross-cutting way, particularly those related to the coordination of diverse interests, as well as politically driven turnover and administrative challenges.

Coordination of diverse interests

The legislative context in Ecuador has changed significantly since 2008, when the new constitution was adopted. The constitution responded to the demands of social and Indigenous movements over many years and sought to establish a national vision grounded in the Andean worldview of *sumak kawsay* (good living, often expressed in Spanish as *buen vivir*) (Peña, 2016). *Sumak kawsay* emphasizes harmony between human

26 Source: INFOCAMPO data, downloaded on 15 March 2024: https://piater.mag.gob.ec/infocampo/.

beings and Mother Earth (*Pacha Mama*), and among other elements, the constitution recognizes the Rights of Nature. For seed systems, it is particularly significant that the constitution established food sovereignty as a strategic objective and obligation of the State, including the preservation and recovery of agrobiodiversity and ancestral knowledge, including the free exchange of seeds (art. 281.6). In addition, the country was declared "free of genetically modified crops and seeds" (art. 401). The following year, a law on food sovereignty, the Organic Law on the Food Sovereignty Regime (LORSA) established a framework for operationalizing food sovereignty and set in motion a legal reform process to revise, replace or develop new laws related to the food system, through a process of broad social participation and public deliberation (República del Ecuador, 2009). Accordingly, LORSA created the *Sistema de Soberanía Alimentaria y Nutricional*, a body composed of representatives from civil society and different levels of government, with the mandate to develop public policy proposals (República del Ecuador, 2010).

The 1978 Seed Act was one of the laws included in this reform process, which ultimately led to the development of LOASFAS, adopted in 2017. The 1978 law addressed only certified seed, and any seed that did not meet certification standards was classified as *semilla común* (ordinary seed) (República del Ecuador, 2004). Although provisions for the internal quality control of *semilla común* for potato were added in 2015 (see Section 4.2), the 1978 law did not support *semilla común*. For decades campesino and Indigenous organizations had demanded greater recognition of their seed practices (Jefferson, 2020, p. 151). As a result of the consultative drafting process, LOASFAS adopted a much broader scope, covering, as its title indicates, agrobiodiversity, seeds, and the promotion of sustainable agriculture. With respect to seed, LOASFAS maintains the certification system for the "conventional seed system", but also includes specific articles dealing with *semilla campesina*, which encompasses both "native" and "traditional" seed. In this sense, LOASFAS takes an approach similar to the "integrated seed systems" developed in several African countries, which promote the coexistence of formal, informal, and intermediate seed systems (Louwaars et al., 2013).

LOASFAS thus represents an attempt to coordinate the interests of diverse actors. According to our interviews, some actors view LOASFAS as a "more comprehensive" framework that "makes agrobiodiversity visible". However, other comments highlight the wide range of perspectives that the law seeks to accommodate. On one hand, several actors working primarily with the formal system argue that there should be stronger control of the seed system to address issues such as illegal seed imports and counterfeit seed. Some also contend that *libre circulación* (free exchange) of seed should not apply to commercial crops such as rice, to "protect" certified seed. On the other hand, some actors argue that implementation of the law lacks coherence and that government programs continue to prioritize industrial crops without investing sufficiently in food security crops, diversification, and agroecology. Others consider the free exchange of seeds to be a fundamental right and reject any form of control or regulation of the seed system. The dissatisfaction of certain civil society groups is reflected in several constitutional challenges brought before the Constitutional Court, shortly after LOASFAS was adopted.[27] This diversity of perspectives—from calls for stronger control to demands for freedom—continues to shape debates within the seed system landscape.

Politically driven turnover and administrative challenges

A recurring topic in many of the interviews is the impact of politically driven turnover on the functioning

27 Most of the legal challenges concerned Article 56, which stated that genetically modified crops and seeds could be used in research. However, there were also challenges related to other issues, such as the definition of "quality seed" (paragraph 28 of the third general provision), and the role of the State in regulating internal quality control of traditional seed (Article 24) and in phytosanitary protection for the access, exchange, and commercialization of semilla campesina (Article 26), among others. In its decision, the Court accepted some of these challenges: https://www.corteconstitucional.gob.ec/sentencia-22-17-in-22-y-acumulados-inconstitucionalidad-de-actos-normativos/

of the seed system, particularly within MAG. Almost all public officials—and several interviewees from NGOs or the private sector—spoke of constant personnel changes in public institutions that occur with each change of government. This especially affects MAG, where frequent turnover occurs not only in leadership positions, which shape agendas and priorities, but also among technical staff, slowing down activities both within the Ministry and in collaborations with other entities:

> The technicians who work there also face a lot of turnover—if the boss leaves, everyone leaves, and this prevents the Ministry from continuing processes, this slows us down, because we are already working with a Director, we explain everything […] and then after three, four, or five months, they leave, and another one comes in, sometimes better, sometimes worse. The lack of continuity of personnel affects things tremendously. In the end, the Director is political, but at least if the technicians stayed, there would be continuity—and that often doesn't happen. (EC-KII-01, Pos. 136).

Several interviewees also argued that there is not enough investment in public research, affecting institutions such as INIAP. Both DENAREF and INIAP's breeding programs have limited budgets for staff and operating costs and are generally dependent on external funding to sustain their activities. At the same time, the public procurement system is highly bureaucratic and often causes delays in the execution of activities—especially problematic for agricultural activities that must follow the agricultural calendar. As a result, INIAP is generally not the main implementing agency for projects but instead collaborates with other institutions that manage the funds. This situation limits the institute's ability to hire staff, and the renewal of aging scientific staff is a concern for several programs. While DENAREF and the breeding programs rely heavily on external funding, INIAP's seed production unit operates exclusively with State funds. In turn, this unit generates income from the sale of seeds and plants, as well as from laboratory services and validation tests for varietal release and registration. In the past, these resources were reinvested in the institute and used to self-finance its activities, but now the revenues go to the State and are not managed directly by the institute. Consequently, INIAP has less autonomy. The challenges associated with the public procurement system also affect other entities such as public universities, and complicate, for example, the activities of CBDAs associated with public institutions.

In this context, one innovation of LOASFAS that several actors consider an achievement is the establishment of the FIASA. Financed by the State, the research fund is intended to reach a budget equivalent to 1% of Ecuador's agricultural GDP but started in 2022 with 0.20%. FIASA supports projects in three strategic areas:[28]

1. The conservation and use of plant genetic resources for food and agriculture, including activities to promote the use of plant genetic resources, CBDAs, genebanks, and plant breeding.
2. Research, innovation and technology transfer for seed production, including both *semilla campesina* and certified seed.
3. Sustainable and efficient agriculture, including agricultural production practices, agro-industry and commercialization, and nutrition and health.

Seventy percent of the fund is awarded through competitive calls, and in the first open call (2023), FIASA supported 18 projects implemented by universities, local governments, and campesino and Indigenous organizations.[29] The remaining 30% is assigned directly to INIAP through an internal competition. In interviews, FIASA projects were cited especially by public officials as a welcome source of financial support with the potential to revitalize seed system activities and that could even serve as a model to facilitate implementation of other laws.

28 Acuerdo Ministerial No. 009, Ministro de Agricultura y Ganadería, 24 January 2022.

29 https://www.iniap.gob.ec/ganadores-convocatoria-abierta-fiasa-2023/

Rice paddy bunds in Daule used to grow cucumber, mango, and maize. This practice has emerged as a recommendation to complement and diversify the intensive rice production system on the Coast. Photo: Sarah Paule Dalle/NMBU

5 PERSPECTIVES FOR IMPROVING THE SEED SYSTEM

In this chapter, we consider seed system actors' perspectives on the most important seed-related challenges and their suggestions for how to improve both farmers' seed security and the role of the National Genebank. These perspectives are important for understanding the motivations and priorities of different actors.

Most important seed-related challenge

In response to the question, "What is the most important seed-related challenge in the country?", key informants shared a wide range of views that touched on all seed system functions (Table 15). It is worth noting that although some interviews were conducted with local seed producers, seed savers and producer associations, most of the perspectives presented here reflect the views of other actors in the seed system (Table 1).

With respect to variety development and management, several interviewees—from both producer organizations and government entities—considered the loss of local varieties and consumers' limited knowledge of agrobiodiversity to be central problems. Some framed this concern as an issue of identity: "in our drive for productivity, we abandon our roots, our origins" (EC-KII-12, Pos. 195). Others saw it as a matter of governance: "Our ability to influence societal change depends on people becoming aware, taking an interest, and educating themselves. So that is the most important challenge related to seed, because you don't defend what you aren't familiar with, you don't defend what you don't even know exists. You only defend it when you know it—and even more so if you use it" (EC-KII-04, Pos. 139). Some actors also argued that the lack of investment in research—and even the underappreciation of plant breeding—is a significant concern affecting the country's ability to cope with climatic changes, such as El Niño, which has impacted maize production on the Coast.

Many responses from breeding programs, NGOs and universities focused on challenges related to seed production. On one hand, several interviewees mentioned problems with handling and storing *semilla campesina*, often emphasizing cultural dimensions. As one person explained:

> There is no real seed management culture, [...] no matter how much training you give [to farmers], they do not grasp what seed is, biologically—that would give you better grain, better tubers. With potato, they select the last ones; it is the same with maize, they take the worst cob; with beans, the last pods. So, basically, seed is not handled properly (EC-KII-08, Pos. 133).

Others mentioned economic factors affecting seed production, such as the tendency of farmers to sell their best potato tubers when prices are high rather than saving them for seed. Still others emphasized that the lack of markets for many agrobiodiversity products limits the possibility of establishing seed producer groups such as CONPAPA, since farmers do not earn enough from their crop to justify buying seed from external sources. On the other hand, a number of informants expressed concerns regarding certified seed production, including insufficient oversight to control counterfeit seed, the limited number of varieties produced, and the lack of domestic vegetable seed production.

In relation to seed dissemination, interviewees pointed mainly to issues in the formal system. Many highlighted the limited use of certified seed, which both farmers and other actors often attributed to its high price. However, some also argued that this is due to customary practices that discourage the use of certified seed, or because farmers are unaware of—or do not appreciate—the potential yield gains.

Additional concerns included illegal seed imports, the sale of counterfeit seed, and the sale of varieties not adapted to local conditions. One interviewee noted that cultural factors also play a role: "Unfortunately, sometimes I think it is cultural, the *viveza criolla* we call it here; people think 'I don't care, I make money from this sack of seed, but I know it's not seed, it's just any grain that I put in there'" (EC-KII-01, Pos. 162).

Finally, several cross-cutting challenges were also mentioned, such as the lack of capacity of local governments and NGOs; the need for protocols to ensure access to seed in humanitarian situations; and inequality and the lack of recognition of smallholder farmers' contributions.

Suggestions for improving seed security

In both focus groups and interviews, we asked for suggestions on how to "improve farmers' access to sufficient quantities of good quality seed of their preferred crops and varieties". The suggestions from the focus groups were presented in more detail above (Chapter 3) but are summarized here for comparison with the ideas raised in the key informant interviews (Table 1).

Access to "preferred varieties" (varietal suitability) depends largely on variety development and management. In Cotacachi, farmers emphasized that they, above all, want to promote the conservation and use of their own varieties, and to maintain their customary practices. To this end, key informants suggested several strategies to promote the use of agrobiodiversity and make family farming more attractive to young people. One proposal was to strengthen the existing network of CBDAs to "decentralize" the functions of the National Genebank, as well as to promote more seed fairs. Interviewees also stressed the importance of developing markets for agrobiodiversity products and promoting a nutrition-sensitive approach that contributes to public health. One person highlighted the importance of *ferias libres* (free or open fairs), where any producer can participate and sell their agrobiodiversity products, without any requirement to register. Farmers in Cotacachi showed limited interest in the development of new varieties, but one interviewee from INIAP argued that it is necessary to understand what characteristics farmers are looking for when they ask for certain varieties to be recovered (i.e. in restitution activities), and to use this as feedback for breeding programs. Related to this, another suggestion was that INIAP's potato program should consider a wider set of criteria in its breeding objectives, to meet diverse local needs.

In Daule, key informants had more suggestions related to variety development than to the conservation and maintenance of diversity, although one focus group indicated interest in receiving training on how to diversify production along the rice paddy bunds. More common, however, was the desire for a new rice variety that better meets farmers' criteria: market acceptance, good yields, and good eating quality. To increase farmers' varietal options, one private sector representative emphasized the importance of having different companies engaged in plant breeding; another interviewee noted that INIAP needs more stable support to focus on research and develop its own rice varieties, rather than just adapting materials from FLAR. Another idea for diversifying the rice production system was to promote *zonificación* (zoning), referring to past practices in which farmers planted varieties adapted to their specific conditions and rotated between varieties. According to one person, INIAP also used to develop varieties adapted to different agroecological conditions which supported this. However, current market dynamics do not favour the use of varietal diversity, leading one interviewee to comment that "we need to work on integrating the value chain; one way or another, we have to bring the *piladoras* into the value chain, so they are not loose wheels" (DL-KII-06, Pos. 260). However, according to one farmer we interviewed, the underlying problems are political and relate to the lack of enforcement of existing regulations.

To improve both the quality and availability of seed, key informants made several suggestions related to seed production. For *semilla campesina*, both the Cotacachi and Daule focus groups requested support to improve their seed production. In Cotacachi, this focused on farmers' own seed production and included techniques for pest control in the field (potato) and for storage (maize). In Daule, the suggestions focused more on the production of *semilla artesanal*, as many farmers cannot produce their own seed (see Section

3.2). A local seed producer explained his vision, which mirrors the mixed seed system strategies promoted in the Sierra:

> What we really need is training and guidance from specialists on the process, so that we can produce seed with the involvement of seed inspectors, and produce quality seed that satisfies consumers, producers, and *piladoras*. This would avoid disagreements and conflicts, because we are part of a value chain and all the links should be connected. I think it would be excellent if we could have a seed-processing facility—and not only for us, as I said, but for several associations in the area that could join together to produce seed (DL-KII-02, Pos. 186).

In the Sierra, several interviewees stressed the importance of supporting mixed seed systems, to make good quality *semilla campesina* more available and accessible. Some proposed supporting decentralized seed producer groups or community seed banks, while also noting the need to identify effective models. One interviewee with experience working with seed producer groups explained: "One part is establishing these decentralized seed producer groups, so that you have good seed, but we also need to identify ways to do this well—that is our task: to think through and say how this can be done better" (EC-KII-17, Pos. 120). Even if such approaches appear attractive, several key informants argued that the lack of market demand for many agrobiodiversity products limits the feasibility of establishing mixed seed systems in areas such as Cotacachi.

Table 15. Summary of responses on the most important seed-related challenge and suggestions from key informant interviews and focus groups for improving seed security.

Function	Most important seed-related challenge (interviews)	Suggestions to improve seed security (interviews)	Suggestions to improve seed security (focus groups)
Variety development and management	Genetic erosion, loss of local varieties Lack of consumer knowledge/ demand for native crop diversity	Re-affirm the value of the country's plant genetic resources Promote family farming, CBDAs, seed fairs, and ferias libres for agrobiodiversity products; adopt a nutrition-sensitive approach	Cotacachi: maintain/ recover lost varieties; campaigns to promote the use of agrobiodiversity and transmit knowledge to youth Daule: demonstrations/ training on how to diversify production along the paddy bunds
	Underappreciation of plant breeding, need for more research Varieties no longer adapted to climate changes (e.g. maíz duro on the Coast)	Develop varieties better adapted to local needs; recover zonificación practices Develop more varieties for different users; integrate piladoras into the seed value chain (rice)	Cotacachi: test varieties to evaluate their adaptation to local conditions Daule: Develop rice varieties that better meet farmers' criteria

Function	Most important seed-related challenge (interviews)	Suggestions to improve seed security (interviews)	Suggestions to improve seed security (focus groups)
Seed production	Seed handling problems, low quality of semilla campesina Development of seed producer groups constrained by lack of market demand for many crops Lack of control in the formal system (counterfeit seed) Few varieties available as certified seed Lack of domestic vegetable seed production; reliance on imported seed	Identify effective models to improve the quality of semilla campesina Increase the quantity and diversity of certified seed: decentralize seed production (potato), produce more varieties, produce seed for minor crops	Cotacachi: support for pest control and potato seed production, improve seed storage (maize) Daule: Training on seed production; access to early generation seed; establish a seed processing plant at community level
Seed dissemination	Low use of certified/quality seed for economic (high price) and cultural reasons Illegal seed imports Sale of counterfeit seed and varieties not adapted to local conditions (certified seed) Few varietal options (rice)	Promote the use of certified seed: raise awareness of producers; reduce costs; increase farmers' purchasing power; increase confidence in seed quality; require proof of certified seed purchase for selling to piladoras Improve seed dissemination and exchange through a storage and distribution centre	Cotacachi: promote seed exchange; make exchanges more effective (disseminate seed adapted to the area); facilitate access to certified seed (Peribuela) Daule: none
Other issues	Need for more committed and coordinated action in favour of farmers Lack of technical capacity at the local level (NGOs, local governments) Lack of protocols for responding to climate change and humanitarian situations Lack of recognition of communities' contributions, rural-urban inequality	Improve support to farmers: rural extension, soil management, irrigation, economic conditions, access to land Strengthen coordination between MAG and INIAP in rural extension work Strengthen MAG capacity and coordination between actors to improve the quality and price of certified seed Coordination between government and social movements to improve the law (LOASFAS) and develop joint strategies	Cotacachi: support to improve productivity and profitability of agriculture: bio-inputs, fertilizer, value-addition, price regulation Daule: ensure piladoras pay a fair price; more continuous and collaborative rural extension; more involvement of the local (canton) government

There were also suggestions aimed at increasing the diversity and availability of certified seed. For example, one proposal was for MAG to request additional resources so that INIAP could produce certified seed of minor crops that private companies are less interested in. Another proposal was to decentralize the production of early generation seed for crops such as potato by involving universities or other actors in potato producing regions, thereby reducing transport constraints and offering a wider range of varieties that seed producer groups could multiply.

Regarding seed dissemination and access, many interviewees focused on promoting the use of certified seed, particularly on the Coast. Several actors argued that farmers need to be made more aware of the benefits of certified seed through mass-media campaigns, practical field demonstrations, and providing variety fact sheets along with the certified seed. Key informants also underscored the need to strengthen rural extension services, as explained by one INIAP technician:

> The only way to break out of this cycle is if both INIAP and the Ministry of Agriculture truly work in the same direction. The technology transfer side needs to be very, very closely connected to MAG, because I know the work they do there and I know how hard it is. A technician does not have a vehicle and must attend 80 or 90 producers per month, but this does not give them enough space to make a difference. It would be different if there were one technician per association or for every two or three associations, focusing only on that—then you can measure results and do a good job in technology transfer (DL-KII-07, Pos. 188).

Many actors highlighted economic barriers to seed access and proposed various approaches to either reduce the cost of seed (allowing INIAP to sell more seed, providing subsidies) or to increase farmers' purchasing power through improvements in production (developing higher-yielding varieties, improving irrigation and roads), ensuring timely access to credit, providing better social services (health, schools), and developing markets for their products. Some also argued that it is important to increase farmers' trust in certified seed through improvements in its quality and price. Proposals to achieve this included stronger coordination between seed producers (INIAP and companies), as well as reinforcing MAG's internal capacity—both technically and in terms of working conditions. Given the complexity of the barriers, one interviewee suggested that immediate results could be achieved if farmers were required to present proof of payment for certified seed as a condition to sell their production to the *piladoras*.

Economic difficulties were also emphasized in the focus groups, as was the lack of enforcement of the official prices established by MAG for different classes of rice (long and short-grain). Farmers noted that these categories are not respected and that long-grain varieties are often paid as short-grain. Although some participants proposed establishing a *piladora* "that pays a fair price" and improving rural extension services, farmers' suggestions overall focused more on improving the quality of local seed producers' *semilla artesanal* rather than facilitating access to certified seed.

In Cotacachi, farmers suggested continuing to support seed exchange among farmers, while ensuring more effective mechanisms to guarantee that the seed distributed is adapted to local conditions. UTN also advanced the idea of establishing a storage and distribution centre among several institutions, to facilitate the dissemination of seed produced at the CBDA and to provide ongoing support for seed-exchange activities.

Suggestions for strengthening the role of the National Genebank

Genebanks did not appear prominently in the earlier discussion of seed-related challenges or suggestions for improving farmers' seed security. However, in the key informant interviews we explicitly asked actors for suggestions on how to strengthen the role of the National Genebank within the seed system. Their responses included a range of ideas, including improving DENAREF's operations and resources, facilitating access to germplasm, establishing or reinforcing partnerships, and increasing outreach about the Genebank's role and activities:

1. Improving operations: Several interviewees familiar with DENAREF emphasized the need to increase financial resources for the Genebank so that equipment and the accessions database can be modernized, and to improve processes for regeneration and safety duplication, to maintain the collections and prevent losses. They noted that contributions from FIASA and various international projects—such as BOLD and KOPIA—are already helping in this process. However, some argued that conservation activities need greater stability and that there should be a permanent allocation of State funding for the National Genebank.

2. Facilitating access to germplasm: Several actors would like to see more easily accessible information (e.g. online) about the accessions conserved by the Genebank and their characteristics, as well as clearer information on the procedures for requesting materials, and on which materials are available for distribution. Some people commented that much of the current access occurs through DENAREF's project-based activities (e.g., restitution to farming communities) or through established institutional partnerships, and that efforts are needed to facilitate broader access for producer organizations or other community and civil society actors. Although efforts have been made to simplify the procedures for farmers to access materials from the National Genebank, our interviews suggest that several actors are unfamiliar with these procedures.

3. Collaborations: There were multiple suggestions for strengthening collaborations with the Genebank, particularly from organizations that already work with DENAREF. For example, universities such as UTN and the Universidad Católica de Ibarra expressed interest in more technical support or exchanges with DENAREF to strengthen their own genebanks or CBDAs. UNORCAC and CCMU expressed interest in more restitution initiatives to respond to specific producer needs and in support for further equipping their CBDA. On the Coast, CESA suggested working with rice materials conserved in the Genebank to refresh the seed of varieties such as INIAP-11, which farmers still grow, and to carry out trials to assess their adaptation to different conditions, including potential future climatic scenarios. AFC also expressed interest in collaborating with DENAREF and other INIAP units on studies related to agrobiodiversity. Finally, SENADI proposed a collaboration to establish a special collection of plant varieties protected under plant breeders' rights.

4. Outreach about the Genebank: Another suggestion was to undertake more outreach on what the Genebank does, as some interviewees were unaware of its work and expressed interest in learning more or understanding how they might interact with it. Some actors also misunderstood its role—for example, thinking that the Genebank serves only INIAP users. The idea was also raised that more public outreach on the Genebank's work would be important for motivating greater support and investment from the State.

Rice and amaranth at the La Pacha Mama nos alimenta Agroecological Fair in Cotacachi, Ecuador. Photo: Luis Salazar/Crop Trust.

6 RECOMMENDATIONS

In the preceding chapters, we analyzed local seed systems in the cantons of Cotacachi and Daule to highlight farmers' perspectives and needs; examined the functioning of the seed system by mapping and assessing the roles, activities, and performance of actors at the local, regional, and national levels in the maize and rice systems; and summarized actors' perspectives on how to improve the seed system. Drawing on the information gathered and discussions held during the roundtable workshops convened in Daule and Cotacachi in August 2024, we propose here several strategic options for improving seed security for small-scale farmers and strengthening the role of the National Genebank.

Expanding market opportunities for a wider range of crop diversity

In both locations, market factors influence the use of crop diversity. This is especially evident in Daule, where *piladoras* report that markets favour SFL-011 because of its culinary qualities that are preferred in the Sierra, which is the main market for rice. Although new varieties have been released to meet this demand, these have yet to penetrate the Sierra markets.

There appear to be few value chains oriented towards local Coastal markets, where consumers—including farmers themselves—prefer other varieties. As a result, many farmers do not plant the varieties they prefer or do so only on small areas. This has also contributed to the decline in varietal rotation practices, which, according to some actors, may have contributed to increased pest pressures and reduced options for climate adaptation.

In Cotacachi, the use of certain traditional varieties is limited by the lack of market opportunities. Although many varieties are maintained for their cultural importance and used for household consumption, land scarcity means that many households must focus on varieties from which they can also generate income. There have been several initiatives to promote local crop diversity and local gastronomy (including the annual seed fair, which now attracts a large urban audience), as well as the development of processed products such as the *Chicha de Jora Sara Mama* beverage. Nevertheless, market linkages remain a challenge for promoting continued agrobiodiversity use in Cotacachi, and a concern for engaging youth who increasingly see little future in agriculture.

Creating space for the marketing and sale of a wider range of diversity—both traditional and improved varieties—appears to be a key condition for promoting crop diversity in production and food systems. This would also help revitalize the seed system by creating demand for seed of different varieties and encouraging breeding programs. At the roundtable workshops, there was broad support among actors in both Daule and Cotacachi for working on this issue. In our interviews, actors mentioned several experiences and methodologies that could be relevant, such as the participatory market chain approach, alternative market channels, and consumer awareness and education.

Promoting access to diverse seeds and associated knowledge

Mechanisms for seed dissemination and knowledge exchange are crucial for facilitating access to—and use of—diversity, including both traditional and improved varieties. In our analysis of seed system functions, we identified several processes that could be strengthened to support greater access to diversity.

In Cotacachi, farmers maintain a diversity of crops and varieties that they produce, exchange, and sell within the informal seed system. While their own farm-saved seed remains the most important source, external sources are essential for accessing and experimenting with other varieties. These sources include other farmers, shops and traders, as well as initiatives led by UNORCAC and DENAREF such as the *Muyu Raymi* Seed Fair, the weekly *La Pacha Mama*

nos alimenta Agroecological Fair, and germplasm restitution and distribution initiatives. Although these sources are valued, farmers noted that seed obtained from them does not always adapt well to their varied agroecological conditions, suggesting the need for more targeted strategies for seed dissemination. This could include participatory adaptation trials to generate recommendations for dissemination, and initiatives to improve access to information on the growing conditions of seed being sold or distributed.

Another suggestion for strengthening access to diversity in Cotacachi was to develop more continuous and dynamic mechanisms for seed dissemination and exchange. Suggestions raised in the roundtable workshops included strengthening linkages between CDBAs and the Red de Guardianes de Semillas to disseminate the materials they conserve, and establishing new spaces for seed sales, such as stalls at the weekly agroecological market.

These initiatives focus primarily on promoting the use of native Cotacachi varieties. However, we also observed that farmers grow some improved varieties, particularly INIAP bean varieties that circulate within the informal seed system. Although many farmers are clearly committed to maintaining their own varieties, this suggests there may also be interest in testing other improved varieties—yet these are not easily accessible because the formal seed system is very weak in the Sierra. Integrating varieties from breeding programs into participatory characterization, multiplication, and dissemination activities—alongside traditional varieties—could offer an avenue for this.

In Daule, the situation is very different, with far less diversity maintained in the production system. There is a well-established formal seed system for rice, with participation from various public and private actors who contribute to varietal development. The use of this diversity is constrained largely by market forces, but some actors also noted a lack of access to information on the range of available varieties. Although seed companies disseminate information on their varieties, this is targeted toward large producers who use more certified seed, while rural extension programs devote little attention to this issue. Greater coordination between actors is therefore recommended to facilitate access to information on the full range of available varieties.

We also observed limited efforts in Daule to promote the use of crop diversity within the production system—such activities are more commonly carried out in areas of high agrobiodiversity. Even with a strong commercial orientation, our results suggest opportunities to promote diversification. Rice and the crops grown along paddy margins are also important for household consumption and valued for their culinary qualities. Some farmers expressed interest in diversifying their systems, for instance by improving management of areas outside the paddies (where some communities already have positive experiences), or even by recovering *criollo* rice varieties remembered for their excellent culinary traits. Some actors also emphasized the importance of recovering varietal rotation practices within the rice production system to break pest cycles. The role of diversity within commercial systems such as Daule therefore merits greater attention in public policies and programs, with participation of different actors.

Improve the quality of seed used by farmers

We found that farmers in both Cotacachi and Daule rely primarily on the informal seed system, despite the very different production systems and cultural contexts. *Semilla campesina*—produced at household level in Cotacachi and by local seed producers in Daule—faces challenges and is a major concern for farmers.

In Cotacachi, farmers reported increasing challenges with pests, diseases, and climatic stress, particularly affecting crops such as maize and potato at lower elevations. Farmers also observed that some traditional and improved varieties are especially vulnerable to these pressures. These issues affect the production of farm-saved seed and, in extreme cases—such as the potato purple top epidemic—farmers in some communities have stopped saving seed entirely.

In Daule, farmers noted that the quality of *semilla artesanal* varies, with some local seed producers carefully managing their plots and others not. Farmers are sometimes forced to buy poor quality seed due to lack of availability from preferred sources or for economic reasons.

One of the main purposes of the formal system is to guarantee seed quality through certification.

Ecuadorian policies have focused for decades on developing the formal system, especially for commercial crops such as rice and *maíz duro*. Farmers in Daule recognize that certified seed has the highest quality, but economic barriers make it inaccessible to many. Subsidies delivered through the *Plan Semillas*' technological packages have facilitated access, but farmers stop using certified seed when such support ends.

Additional strategies to improve farmers' purchasing power—given the complexity of the issues—range from reducing production costs (soil analysis, promotion of bio-inputs) to improving incomes (improving production, market access and prices farmers obtain), improving access to credit, and strengthening social services. In places like Cotacachi, the issues are different: the formal system is very underdeveloped in the Sierra, and farmers have a strong preference for local varieties and their own seed production.

Given this context, farmers in both regions suggest greater support to improve the quality of *semilla campesina*. However, our analysis shows that very few actors are dedicated to this issue. While the law guarantees farmers' rights to conserve, produce, and exchange their seed, there is little support to improve the quality of *semilla campesina* itself; investments are directed primarily to the formal system.

An exception is the experience with mixed seed systems that INIAP and other partners have developed in parts of the Sierra, in which groups of farmers are trained to produce seed and carry out inspections using internal quality control procedures. This approach offers a potential model for supporting the production of good quality *semilla campesina*, and the legal framework even allows for it. However, discussions at the roundtable workshops surfaced important considerations. In Daule, many actors in the formal system see strengthening local seed production as a threat to certified seed or are sceptical that internal control protocols can achieve acceptable seed quality without following certification standards. In Cotacachi, the idea of developing norms or protocols for seed quality is questioned by some actors who emphasize that *semilla campesina* should not be regulated by the State and that such protocols could undermine ancestral knowledge and practices.

These points illustrate the range of challenges involved in improving the use of quality seed in Ecuador. The formal system offers an option for certain crops, but expanding the use of certified seed will require coordinated and sustained efforts to address the economic barriers many farmers face. At the same time, the informal system—through the production, exchange, and sale of *semilla campesina*—offers far greater crop and varietal diversity and represents the lion's share of the seed farmers currently plant. It is therefore essential to find ways to improve the production of *semilla campesina* that can be adapted to different realities across the country, and to encourage more dialogue at the policy level in this area.

Strengthening the role of the National Genebank within the seed system

DENAREF has the mandate to both conserve and maintain plant genetic resources in the National Genebank's *ex situ* collections and to promote the sustainable use of agrobiodiversity. Through these activities, DENAREF has developed multiple linkages with actors in the seed system. On one hand, DENAREF maintains and provides germplasm used in breeding programs—particularly those of INIAP working with native germplasm—and also conserves breeders' materials. On the other hand, through its mission to support *in situ* conservation, DENAREF has established linkages with local organizations (farmers' organizations, local governments, and universities) to organize seed fairs, germplasm recovery and restitution initiatives, and educational programs on agrobiodiversity—all of which are recognized in the law.

For the Genebank to be used more broadly, especially by actors outside INIAP, outreach is essential to raise awareness of DENAREF's role and to make information about available accessions, procedures, and conditions for requesting germplasm—whether for research or for restitution—more accessible. Improving genebank operations (for example, regeneration of materials and modernizing the accession database) is also fundamental. As a catalyst for initiatives promoting the sustainable use of plant genetic resources on the ground, DENAREF can also collaborate with other actors to improve farmers' access to diversity. The

seed security framework used in this study broadens the perspective beyond the *in situ* conservation focus that has shaped much of DENAREF's local level work. For example, although these initiatives have focused on areas of high agrobiodiversity, our results suggest that it is also important to consider how diversity can be promoted in areas strongly driven by commercial interests. Likewise, methodologies for germplasm recovery and restitution should continue to be developed—for instance, by incorporating approaches to ensure that seed offered to farmers is adapted to local conditions, and by linking these efforts with initiatives to improve the quality of *semilla campesina*.

Verónica Cumba and her son. Cotacachi, Ecuador. Photo: Luis Salazar/Crop Trust.

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Appendix 1. Crops and their common and scientific names

Common names in English, corresponding Spanish names, and scientific names of crops referenced in this report. For culturally specific Andean crops (*), the Spanish/Kichwa term is used in the main text for clarity and cultural accuracy. An English gloss is provided on first mention.

English name	Spanish/Kichwa name	Scientific name
Andean blackberry	Mora	*Rubus glaucus*
*Arracacha**	Zanahoria blanca	*Arracacia xanthorrhiza*
Barley	Cebada	*Hordeum vulgare*
Bell pepper	Pimiento	*Capsicum annuum*
Broccoli	Brócoli	*Brassica oleracea var. italica*
Cabbage	Col	*Brassica oleracea var. capitata*
Carrot	Zanahoria	*Daucus carota*
Cassava	Yuca	*Manihot esculenta*
Chickpea	Garbanzo	*Cicer arietinum*
*Chocho**	Chocho	*Lupinus mutabilis*
Common bean	Fréjol	*Phaseolus vulgaris*
Cucumber	Pepinillo	*Cucumis sativus*
Fava bean	Haba	*Vicia faba*
Goldenberry	Uvilla	*Physalis peruviana*
Green bean	Vainita	*Phaseolus vulgaris*
Lentil	Lenteja	*Lens culinaris*
Lemon	Limón	*Citrus limon*
Maize	Maíz	*Zea mays*
Mango	Mango	*Mangifera indica*
*Mashua**	Mashua	*Tropaeolum tuberosum*
Melon	Melón	*Cucumis melo*
*Melloco**	Melloco	*Ullucus tuberosus*
*Miso**	Miso	*Mirabilis expansa*
*Oca**	Oca	*Oxalis tuberosa*
Onion	Cebolla	*Allium cepa*
Pea	Arveja	*Pisum sativum*
Pigeon pea	Fréjol de palo	*Cajanus cajan*
Plantain	Plátano	*Musa balbisiana*
Potato	Papa	*Solanum tuberosum*
Quinoa	Quinua	*Chenopodium quinoa*
Rice	Arroz	*Oryza sativa*
Rye	Centileno	*Secale cereale*
*Sambo**	Sambo	*Cucurbita ficifolia*
Sweet granadilla	Granadilla	*Passiflora ligularis*
Sweet potato	Camote	*Ipomoea batatas*
Swiss chard	Acelga	*Beta vulgaris var. cicla*
Tomato	Tomate riñón	*Solanum lycopersicum*
Watermelon	Sandía	*Citrullus lanatus*
Wheat	Trigo	*Triticum aestivum*
*Zapallo**	Zapallo	*Cucurbita maxima*

Quinoa in the hands of Magdalena Laine. Cotachachi, Ecuador. Photo: Luis Salazar/Crop Trust