Forage and hybrid dual-purpose maize seeds market analysis in northern Lao PDR

INITIATIVE ON Mixed Farming Systems

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1. Introduction

Mixed Farming Systems (MFS) is a CGIAR research initiative aimed to create equitable and transformative pathways to improve the livelihoods of stakeholders through the sustainable intensification of crops and livestock production across six countries. In Laos PDR, cattle hold a pivotal role within the project's development agenda. This focus reflects significant regional shifts in livestock production, as subsistence agriculture transitions to commercialized and modernized systems. Additionally, the sector's potential to integrate into the rapidly growing Southeast Asia (SEA) markets, such as China and Vietnam, further underscores its importance. Demand for cattle products in these markets is increasing, and Northen Laos, in particular, has strong trade connections with China, supported by recent international trade agreements. However, Laos PDR has struggled to meet the standards required for cattle commercialization under these agreements (Mienmany, 2023). One of the major challenges in meeting these standards is overcoming significant bottlenecks in livestock feeding practices among smallholders. These include inadequate feed quality and quantity, and reliance on traditional grazing methods such as free-range feeding on fallow land, natural pastures, rice paddies, roadsides, or forests (Owusu-Danquah et al., 2023).

In line with the MFS project's objective to transform the livestock sector by improving access to and sustainability of agricultural technologies, a series of trials involving forages (grasses and legumes) and dual-purpose hybrid maize has been conducted in Northern Laos. These trials aim to address feeding bottlenecks and enhance crop and livestock productivity. Many studies on the adaptation and scaling of forages and hybrid maize have focused on their suitability for local conditions and their impact on improving productivity, economic outcomes, and sustainability for small and medium-scale farmers. However, understanding the market structure is equally crucial. Seed market analysis enables the identification of opportunities for farmers to access or adopt new varieties, highlights key competitors limiting adoption and explains their influence, and informs strategies for scaling. Such insights can guide governments, private enterprises, and project implementers in positioning new seed varieties more effectively.

This report employs a qualitative approach to analyze the forage and dual-purpose hybrid maize seed industry using Porter's Five Forces framework (Porter, 2008). A multistakeholder perspective was adopted to integrate the diverse views of actors directly or indirectly involved in the production, commercialization, and technological development of these seeds. Stakeholders interviewed included smallholder seed producers, local traders, small- to medium-sized private seed companies, local authorities, and national research entities.

The results shows that while the new seed varieties and associated feeding innovative strategies have significant potential to improve the livelihoods of smallholder farmers and drive the sustainable intensification of the livestock and maize sector, targeted incentives are required to engage other stakeholders both within and beyond Laos. These stakeholders are critical for promoting, marketing, and scaling these innovations. Furthermore, scaling efforts must consider the social models that shape livestock and maize production systems, including seed acquisition and feeding strategies. In the case of hybrid maize, addressing limitations in production capacity and incentivizing key market players to participate is essential to establish a competitive presence and mitigate risks posed by established multinational competitors.

2. Materials and methods

A qualitative approach was used to conduct a market analysis of the forage and hybrid dual-purpose maize seed industry in northern Lao PDR. The forage seed market analysis focused on the main forages produced for cattle feeding, even though these varieties are produced not only for local markets but also to meet demand in neighboring countries and overseas countries. We also asked about opportunities for hybrid varieties and forages (legumes and grasses) that have been trialed during the project implementation (Table 1). Since forages can be multiplied using different types of reproductive material this study adopted a broad definition of the term 'seed', including all types of reproductive material (true, sexual, or botanical seed, and vegetative reproductive material such as cuttings, rhizomes, stems, or grafting materials) (Abizaid et al., 2016; Andrade-Piedra et al., 2020). On the other hand, even though it is mainly used for grain production, hybrid dual-purpose maize production has slowly gained importance in livestock feed basket in northern Lao PDR, especially to maintain fodder productivity during the dry season. Therefore, the analysis of the maize seed industry only focused on this variety and its substitutes.

Table 1. List of forages (legumes and grasses) assessed in northern Lao PDR.

Forage legumes	Forage grasses
• *Crotalaria juncea* • *Crotalaria ochroleuca* • *Lablab purpureus* • *Clitoria ternatea* • *Stylosanthes guianensis* cv. Ubon	• *Urochloa* (syn. *Brachiaria*) *hybrid* cv. Cayman-BH1 • *Megathyrsus maximus* (syn. *Panicum maximum*) (Namsoung) • *Urochloa hybrid* cv. Cobra-BH2 • *Urochloa hybrid* cv. Mulato II-BH3 • *Megathyrsus maximus* cv. Mombasa • *Urochloa ruziziensis* (Namsouang) • *Urochloa hybrid* Mestizo-BH4 • *Urochloa ruziziensis* x *U. decumbens* x *U. brizantha* – Camello • *Urochloa ruziziensis* x *U. decumbens* x *U. brizantha* – *Okapi*

Source: Owusu-Danquah et al., 2023.

Information was collected using key informant interviews (KII), considering a multistakeholder approach to analyzing both seed markets. This led us to use different protocols according to the stakeholder type and the relevant information they would provide based on their links with each seed industry (such as seed producers, traders, private companies, research and development, and local authorities). A total of 45 KIIs were conducted with the main stakeholders for the forage and hybrid dual-purpose maize seed industries. The study areas were the Phoukoud and Kham districts in Xiengkhouang Province (XKH) and the Phonxay and PakOu districts in Luang Prabang Province (LPB) (Table 2). Secondary information was also helpful to better understand specific aspects of market and value chain dynamics not addressed in the interviews.

The sampling combined different methods. Since the forage/maize seed business landscape comprises different stakeholders, we used purposive and quota sampling. By approaching stakeholders selectively, we expected to get a broad overview of their experiences. The predetermined target numbers for each stakeholder type also included a gender proportion of at least 30% in each category. We centered our interest on stakeholders with roles in seed harvesting and production, seed selection and innovation, seed local distribution, as well as local authorities overseeing these aspects. However, the forage and maize seed value chains are comprised of different types of actors. For the forage seed

production chain, our approach involved interviewing small-scale forage seed farmer producers, local traders, research and development entities, and relevant local authorities. Private companies in charge of the large-scale production, cleaning, and marketing of forage are in neighboring countries (Thailand and Cambodia), so these interviews were conducted online and in English. In the case of maize, seed production is mainly carried out by large business conglomerates and government institutions that trial and introduce varieties to the country. Therefore, we focused on government institutions and the seed distribution network. The list of stakeholders to be interviewed started from a preliminary list compiled throughout the MFS intervention. Starting from this list, the implementing partner, the Lao Farmer Association (LFA), with the support of local authorities, facilitated a snowball sampling method to reach mainly forage seed farmers and seed forage/maize traders. Except for the stakeholders mentioned previously, all the interviews were conducted in Lao, and the LFA was in charge of providing feedback and translating protocols from English to Lao, as well as for collecting the data.

Table 2. Sample size by stakeholder category, value chain, gender, and location.

Category	Forage			
	XKH	LPB	Other locations	Total
Smallholder forage seed producers	7 m 3 w	4 m 5 w	–	11 m 8 w
Public entities – research and development	–	–	2 m 1 w (Vientiane Capital)	2 m 1 w
Dissemination, distribution, and trade – local traders	2 m 1w	2 m 1 w	1 w	4 m 3 w
Private companies	–	–	3 m (Online)	3 m
	Dual-purpose maize hybrid			
Dissemination, distribution, and trade – local traders	1 w	1 w	–	2 w
Government officers – local authorities (DAFO, PAFO)	2 m	1 m	–	3 m
Public entities – research and development	2 m	–	–	2 m
			Total	39
			Men (m)	25
			Women (w)	14

The data were analyzed using content analysis method, and we used N-Vivo software to explore data based on pre-established categories. The pre-established categories followed Porter's Five Forces Framework for Industry Analysis (Porter, 2008), adapted for the forage and maize seed industry and its different stakeholder types along the value chains (Figure 1). Industry analysis allows one to understand the immediate environment in which those organizations operate and compete to provide a product or service. By analyzing the several competitive forces that shape every industry and its network value, it is possible to determine the industry structure, recognize patterns that affect those who participate in it, identify factors for successful competitive positioning (Ghemawat & Collis, 2010). The framework provides insights into the industry's profitability and ability to improve accessibility to the products or technologies it offers its consumers, guiding the strategic formulation. An emphasis on an extended competition for value rather than competition among existing rivals encourages to look beyond direct

competitors and consider environmental competitive forces (Ghemawat & Collis, 2010). As the data analysis progressed, emerging sub-categories were added to the analysis framework.

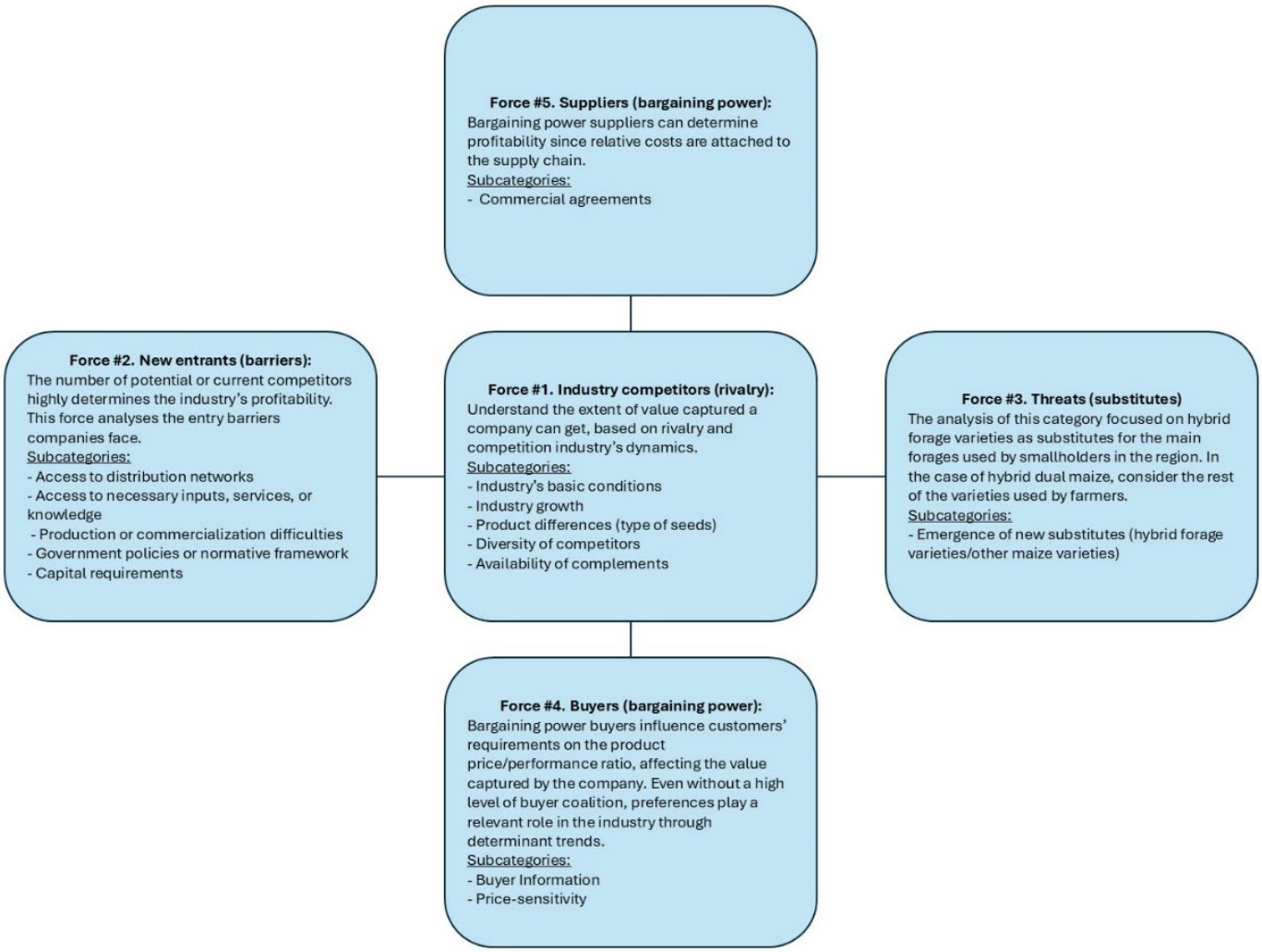

Figure 1. Categories of the framework analysis.

Source: adapted from Ghemawat & Collis (2010) and Porter (2008).

2.1. Limitations of the research

The study is limited to key stakeholders involved with forage and dual-purpose hybrid maize seeds in Northern Laos. This includes smallholder forage seed producers, local traders, local government authorities, national research entities, and few small to medium private companies. The findings represent the authors' interpretation based on the experiences and perceptions of the participants and are not intended to be generalizable. However, they provide an overview of how these markets operate and offer a better understanding of the conditions needed to sustainable intensify livestock and cash crops cultivation in mixed farming systems in Laos, using animal feeding innovations as an entry point. This, in turn, supports the broader scaling of these efforts and the achievement of the project's goals.

3. Results

The results of both seed industries (forages and dual-purpose hybrid maize) follow the structure of Figure 1. First, a brief map shows the type of stakeholders interacting along the industries, most of which were surveyed for this study (Figure 2 and Figure 3). For each force, the description will include the different perspectives of the stakeholders in the industry.

3.1. Forage seed industry

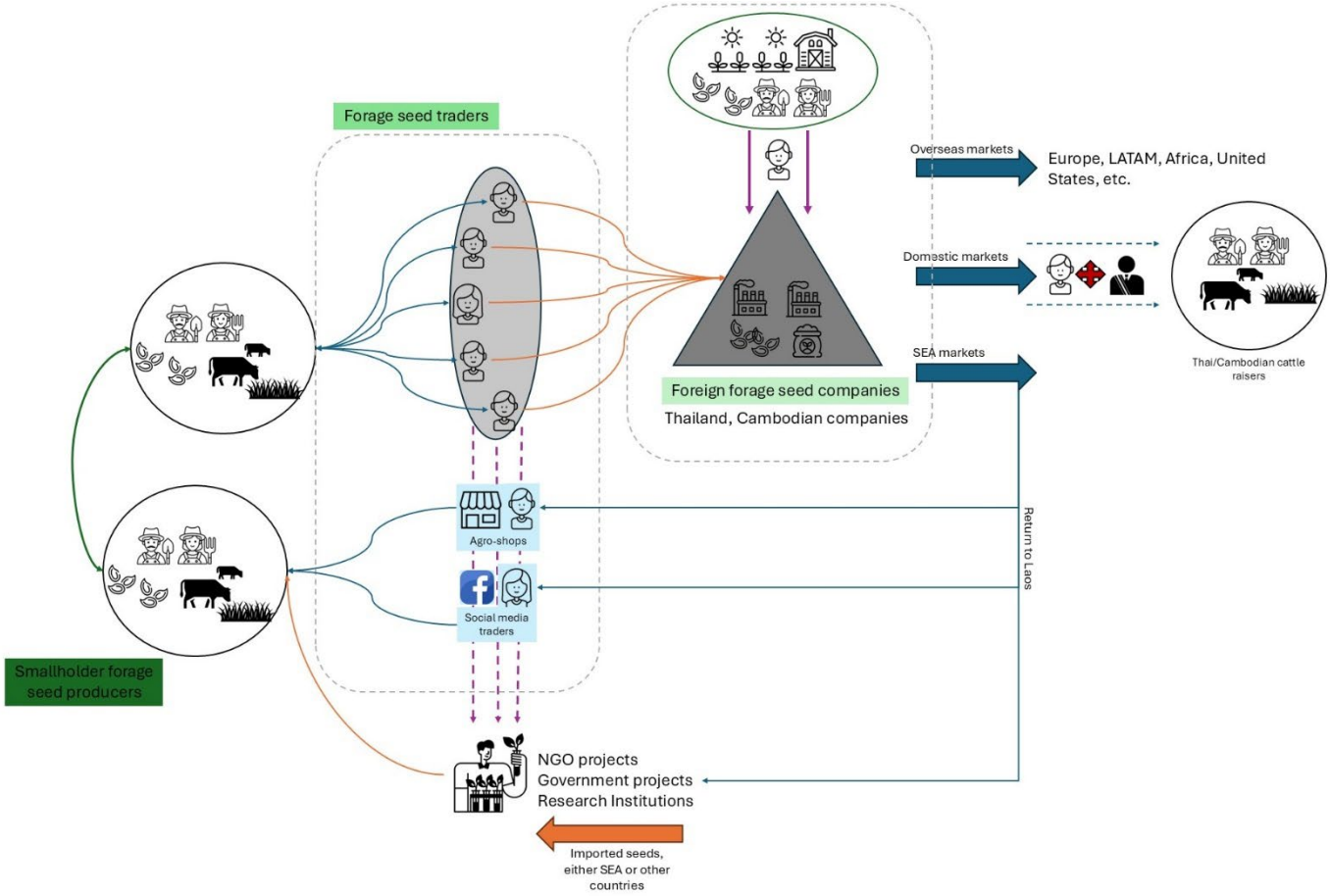

Figure 2. Forage seed supply map from Northern Laos.

3.1.1. Force #1. Industry competitors (rivalry)

A. Industry basic conditions

Smallholder forage seed producers

We found the smallholder forage seed producers producing mainly Ruzi (*Urochloa ruziziensis*) seeds and Napier (*Cenchrus purpureus*) stems. Seed production methods are mainly manual or traditional since they usually apply little to no attempt at modern techniques (such as mechanization or inputs like fertilizers, among others). Most smallholder seed producers rely on non-mechanical tools, either to prepare the soil or for harvesting activities. Relatively few reported the use of tractors and fuel-powered grass mowers. The most widespread belief among producers is that once the seeds are dispersed, *´they will grow on their own and naturally´.* The highest costs and investments for forage seed production are allocated for building fences (wires, fuel to transport inputs, posts), land preparation (use of a tractor, if

any), plot maintenance, and labor. However, none of the interviewed producers keeps records of their seed production activities and associated costs.

The different levels of modernization of the production process are reflected in strongly varying yields among producers. Despite this, Ruzi grass yields are high and, in some cases, can reach around 1 ton/hectare in optimal conditions. Contrasted with species such as Napier grass or Guinea grass (*Megathyrsus maximus*) (yields around 200 kg per hectare), Ruzi grass does not require major investments in time, resources or care, and it regenerates after harvest, making it the preferred variety by forage seed producers. Feeding livestock is the main encouraging factor for growing Ruzi grass, but some farmers have sold the seed surplus, taking advantage of the commercial opportunity. Institutional support for the first sowings of Ruzi grass, through the delivery of seed and technical guidance, was key to promoting this practice.

Seed harvesting is also done manually. The seeds are left to dry in the sun and are manually sorted, separating the good seeds from those that are rotten or in poor condition. Many of them claim to have adapted the method of harvesting and cleaning the seed from rice production, using tools easily available on their farms, buckets, or sieves made by themselves (Picture 1). The cultivation of Ruzi grass in the region dates to around 30 years ago (1990), so the most experienced farmers have adapted their own means to make the harvest more efficient.

Producers obtain Ruzi grass and other grasses seeds from different sources. The main source is free distribution by the Department of Agriculture, but farmers also obtain seeds through annual purchases from traders and online orders, which reach villages and deliver to homes, reducing transaction costs. Social media such as Facebook are very popular for seed marketing. Ruzi Grass seeds are easily found in markets such as those in the Pang, Paek, Pak Saeng, and Phon Xay districts. In addition, some farmers keep a volume of seeds for replanting them in the following season, ranging from 70-200 kg/year.

Picture 1. Sieve developed by farmers to harvest and select forage seeds. Photo by A.Bravo/CIAT.

The capacity and scale of production, measured in terms of the area cultivated with Ruzi grass, varies among farmers and largely depends on the total farms´ area available, the intensity of their livestock activity, and the relevance of seed cultivation for sale and income generation. This results in a wide range of areas under cultivation, ranging from 1-3 hectares for smallholder farmers to 25 hectares or more for larger farms. The area is also carefully separated. That is, the cultivation of grass for animal

feed is separated from the cultivation dedicated to seed production. To make this division, some farmers have implemented the use of living fences with timber trees (with species such as *Tectona grandis*), which are then used for local construction or sold. The division of the plots is also due to the geographical dispersion of the farmers' farms.

During the data collection for this study, farmers claimed to have sufficient capacity, and even an oversupply, of Ruzi grass seeds to meet market needs. In fact, they have recently faced a drop in the price of seed that has impacted their income flow. The pricing mechanism for forage seeds is mainly supply and demand. In 2024, the price per kilogram of Ruzi grass was between LAK 8,000-12,000, compared to the 2023 price band of LAK 22,000-30,000 (a reduction of about 150%). Meanwhile, Guinea Grass seeds can be marketed at LAK 25,000/kg. Each farmer harvests seeds annually, but the range of dates is not synchronized in the region, guaranteeing a constant supply of Ruzi Grass seeds for between 8 and 12 months. The period with the highest sales volumes is recorded between December and March.

Local forage seed traders

Local retail marketing of forage seeds is concentrated in Ruzi Grass seeds, followed by other varieties such as Guinea Grass and Mulato. The seeds are sourced through a supply network established by traders in the two provinces analyzed, LPB (Phonxay and PakOu districts) and XKH province (Phoukoud district). Traders noted that their initial forage seeds supplies came from Mueng Xeng village, but their network has since expanded to include numerous villages and settlements, such as Lae village, Joy village, Mixay village, Bong village, Lao Phonthong village, Phonthong village, Phonxay district, LPB province. Additionally, PakOu district in LPB province and Phoukoud district in XKH province are highlighted as key sources of forage seeds.

The experience of local traders in the forage seed business varies widely. Some have been active for over a decade, while some have only been in the industry for a few months, reflecting an increase in competition within the forage seed distribution chain.

Local traders operate in different ways. Some have stores near central markets where they sell seeds alongside other agricultural products, while others collect the seeds, store them at home, and distribute them to their customers. They do not always have the infrastructure for proper storage and preservation of forage seeds. Common storage practices include using rodenticides to prevent rodents' damage and employing sorting machinery to remove weed contamination.

Those who sell seeds as part of a broader business of selling agricultural inputs in a store may or may not offer delivery to their customers. Buyers in other provinces typically receive their seeds through transport companies such as Anushit, Hong Aloun, or Mixay. At the village or settlement level, traders often use personal transportation to deliver forage seeds directly to their neighbors.

Sales of forage seeds peak in the rainy season, between May and June. Sale volumes depend on the scale of the traders. Provincial-level traders reported selling approximately 25 tons of Ruzi grass seeds in 2023, with prices ranging from LAK 15 million per ton earlier in the year to LAK 40 million per ton by the end-year. In contrast, village or settlement-level traders sell smaller quantities, averaging 2-3 tons per year of Ruzi grass seeds.

Private forage seed companies

Forage seed production and commercialization in Laos cannot be addressed without also considering the neighboring countries, as northern Laos is a part of a supply chain of forage seeds, that flows across various Southeast Asian countries (Thailand, Cambodia, Laos, and even Vietnam). The companies interviewed are two medium-small companies in Thailand, and one start-up in Cambodia, with an experience of 30, 10 and 5 years, respectively. Before establishing their companies, the directors of these companies have worked on development projects with NGOs and government initiatives in the agricultural sector. Their motivation for creating their companies derives from their knowledge of the

sector and opportunities for value creation in the region. Being involved in that kind of program also influences their companies' sustainability operations principles.

The operation model is quite similar among them and combines practices like 1) renting land for seed production managed by farmers with technical support from the company, and 2) getting the forage seeds through farmer networks/traders or farming contracts, which are managed through one person, the main coordinator, who oversees the seed collection and contract management (payments, loan of seeds and production inputs, production volumes, etc.). This last practice includes importing seeds from Laos, to clean, process and re-export them. Forage seed production techniques combine manual techniques with mechanized systems. Most farmers clean the seed by manual *windowing*, adapting traditional methods from rice production.

The main target markets of the Thai companies are large clients in the United States, Europe, Africa or overseas countries that demand high seed cleanliness and purity standards. For these companies, with the largest trajectory, seed marketing in the region is a minimum quota (not more than 20% of its total production yearly) and mainly corresponds to cheaper second-grade seed. This allows companies to reprocess the discarded product meant for their niche markets and place it on the domestic market at low prices. For example, the marketing price in 2023 of *Crotalaria juncea* in the domestic market of Thailand was around 12 baht per kilo, while the regional export price was 23 baht per kilo, and the overseas export price was 33 baht per kilo. The main competitors in the overseas markets are Australian companies, which are key in determining the export price of the seed produced in SEA.

The Cambodian start-up company's target markets compromise higher quotes for domestic and SEA markets than their Thai counterparts. However, although it is sowing large areas, it is still struggling to adapt its seed production methods to local conditions, resulting in low yields. According to the interviewee, their seed production techniques for cover crops are based on regenerative agriculture and agroecology practices. Farmers sow before or after the main annual crop (such as rice or maize), which allows them to reduce soil plowing, fertilizer use, and labor costs. The company started building its supply network with livestock raisers because some of the produced species are suitable for forage.

Research and development national institutions

The two national institutions interviewed were the National Agriculture and Forestry Research Institute (NAFRI) – Livestock Research Centre (LRC), under the Ministry of Agriculture and Forestry (MAF), and the National University of Laos (NOUL). NAFRI operates nationally and is one of the implementing partners for the MFS project, which is testing innovative forage varieties for Laos (Table 1). According to the interviewees, these institutions receive limited operational funding from the government, relying heavily on support from development projects and international cooperation from countries such as New Zealand, Australia (through Australian Centre for International Agricultural Research - ACIAR), Japan, and South Korea (Korea International Cooperation Agency - KOICA). One interviewee noted that projects to test and introduce improved forages varieties often require significant funding, ranging from 2 to 5 million dollars just for one province and three districts.

In the past, the LRC conducted trials on several forage species and engaged in seed production for the most promising varieties to distribute to livestock farmers and teach them how to produce for themselves. However, seed production activities were suspended due to challenges with insufficient production scale, particularly with species like Mulato II. Compared to Ruzi grass, Mulato II seed yields were very low and required more intensive management. This disparity suggests that the high yield of Ruzi grass seeds is a key reason for their continued use. Ruzi grass seeds are more accessible to farmers, and they can use it for both livestock feeding and seed marketing, making the region a productive hub for this variety. Consequently, replacing Ruzi grass has been difficult, even after its seed market price has dropped significantly and even though it cannot meet the animal feeding demands in the dry season.

Additionally, NAFRI and private traders on Facebook, primarily based in Thailand, were identified as key facilitators for delivering forage seeds to livestock development projects. NAFRI works with two private companies in Thailand to get the forage seeds.

B. Product differences (type of seeds)

Local forage seed traders

According to the local traders, northern Laos commercializes mainly Ruzi grass seed. Their opinions affirm *it´s the most demanded, most popular among livestock raisers, and most suitable for the region's agroecological conditions*. According to the local trader's scope, some of them can acquire around 50 tons of Ruzi Grass seeds and other varieties; meanwhile, those who sell in villages or settlements buy around 1,600 kg of Ruzi grass for its commercialization. There exist traders who also offer varieties such as Guinea grass, Mulato, Paspalum, and Stylo.

Private forage seed companies

Product differences vary according to the company's role, either commercial seeds production through farmer networks or buying seeds. When producing seeds, they count with *Crotalaria juncea*, a fast-growing legume. It is suitable for fodder, and its stems are tough, making it ideal for paper and rope making; and it is easy to expand its production with the farmer networks, since it is sown after the rice crop (between late October and November), using the residual moisture in the soil. Other varieties are Guinea grass seed, Stylo, Mulato II (Mulato II plant variety rights belong to Grupo Papalotla from Mexico), and twelve species of cover crops. The seed production is certified and customers are provided with a germination rate guarantee. When companies from other countries buy seeds from Lao farmers, they mainly buy Ruzi grass from the XKH province and, in a lesser proportion, Mulato II through a trader who buys seeds from Oudomxay, LPB, and XKH provinces. The amount of seeds imported from Laos by one Thai company in 2023 was about 12,000 kg.

C. Industry growth

Smallholder forage seed producers

Farmers interviewed show widespread interest in expanding their pasture areas, mainly to meet the growing demand for forage and forage seeds, and in improving the quality and productivity of livestock feed. Some farmers plan to increase their areas under seed production by about one hectare, while others are looking to introduce new varieties of grasses with better yield or resistance, with some of them considering participating in Agriculture Department programs that help them with the initial inputs or planting materials.

Private forage seed companies

The forage seed market outlook is promising, particularly for overseas markets, as noted by interviewees. Some companies are even planning to expand their processing plants to meet the growing demand worldwide. Nonetheless, most smallholders in SEA have not adopted improved forage varieties, partly because of the high price and lack of knowledge dissemination about these forage varieties. Although cattle producers in the region are keen to modernize their production systems and enhance competitiveness, several challenges remain. These include uncoordinated production, scarcity of funding, and, in certain cases like Vietnam, the drop in price the beef market, which discourages investments in improved forage varieties or innovations in animal feeding. A strategy proposed by interviewees to stimulate the demand for improved forages among smallholders in SEA, involves fostering better coordination among farmers, through cooperatives or farmer groups, and ensuring consistent technical and input support from governments or development initiatives.

Research and development national institutions

According to the interviewees, the cattle marketing agreement between Laos and China, along with the increasing demand for beef from neighboring countries, are key drivers for modernizing and expanding beef production in Laos, which in turn stimulates growth in cattle feed and fodder markets. Demand for cattle feed is increasingly moving towards strategies that enable cattle raisers to fatten native breeds within three years to reach a target weight of at least 280-300 kg, meeting the standards required by these markets.

While smallholders, who make up the majority of cattle producers, face significant challenges in achieving these standards, large fattening farms are better prepared. They manage their own feed resources and even place direct orders with traders in Thailand to obtain fodder seeds. Despite the challenges faced by smallholders, there are opportunities for them to improve their self-sufficiency in feed management. In this context, although the expansion of improved forage and feeding practices has an indisputable great potential, an effective approach thus far has been the establishment of community-based, self-sufficient production and supply networks. These networks empower smallholders by fostering local collaboration, reducing dependency on external suppliers, and enhancing the accessibility of quality feed resources.

Developing these networks has become the main focus for recent interventions for livestock development projects, which rely on lead farmers to introduce improved varieties to their communities. As one interviewee explained:

> *'The forage market? Um, I asked the farmer in the, in the area, in the rural area […] They say that they get the seed from their neighbor. It means the project introduces the seed to the model farmer, and then the model farmer sells to neighboring* [farmers].' (R&D's interviewee, personal communication, July 23, 2024).

D. Diversity of competitors

Smallholder forage seed producers

A growing number of small producers carry out Ruzi grass seed production. At the same time, the number of traders has increased, reflecting a diversification of stakeholders in the industry. The opportunity to obtain economic benefits from the sale of forage seeds has been a major driver that has attracted farmers, who have now allocated small plots on their land for this purpose. This has caused the Ruzi grass market to drop, generating uncertainty and demotivation. In light of this, suggestions range from assigning one person from the community to monitor the quality of the seed, which could help to improve and guarantee quality and thus attract customers willing to pay higher prices. Others are betting on the diversification and improvement of grass varieties, looking for other forage varieties that are more competitive and adapted to market demands. Finally, there are those who prefer to conserve the seeds and allocate the forage production for domestic use, at least until seed prices become more favorable again.

Local forage seed traders

There exists a growing number of local traders who recollect the forage seeds and redistribute them to the domestic or international markets. Local conditions for forage seed production favor the presence of multiple traders; the offer is wide, which facilitates access to the product, and anyone who grows forage can harvest it and distribute it on their own.

Private forage seed companies

Competitors depend on the type of company, since each of the interviewed companies target a different market segment. The startup company in Cambodia sees the Thai companies as competitors

because their seed production system is highly intensified. This allows companies in Thailand to produce higher yields of varieties like Stylo, even when some farmers harvest manually. Conversely, for Thai companies with main market niches overseas, the biggest competitors of their forage seeds are Australian seeds. According to the interviewees, Australian seed production conditions and their highly intensified production system allow for very high production levels, although it also results in the highest volumes of shattered seeds. This situation pushes Thai companies to be price-competitive and preserve quality. The SEA's big dairy or feedlot companies are not their main customers. Because of their intensified production system, these clients concentrate on byproducts or annual crop seeds for feeding their animals rather than forage or perennial grasses. Their suppliers are very large companies such as Pacific Seeds or CP, producing hybrid maize and sorghum varieties.

Both types of companies, medium-small Thai companies and the Cambodian startup, agree that smuggling is the biggest competitor when getting and selling the seed. At borders, more than 90% of traded seeds correspond to smuggled seeds. Since these seeds do not go through official procedures required by the exit and entry country, their price is lower. Different actors participate in this dynamic, from regional traders to commercial companies from neighboring countries. The situation affects seed quality because, in most cases, these traders are unfamiliar with preserving the seed or having storage or drying facilities.

E. Availability of complements

Smallholder forage seed producers

Although Ruzi grass is used both as a livestock feed source and for seed production, farmers also use, produce, and sell seeds/planting materials of Napier grass and Guinea grass. Even after growing Ruzi Grass for years, farmers are interested in trying out promising new forage varieties, although their primary reason is to improve their livestock productivity rather than to market the seed. Even though they are motivated to innovate, access to resources and institutional support are key factors that condition their willingness to experiment. However, both for livestock feed and for seed marketing, farmers do not anticipate a significant competitor to Ruzi Grass in the near term.

Ruzi Grass faces hard yield reductions during dry periods. This is why many farmers are keen to experiment with varieties that are more resistant to drought and adapted to adverse weather conditions. Thus, among the breeding opportunities, farmers highlight the need for a forage variety that can be grown between January and May, when Ruzi grass faces the greatest yield challenges.

Local forage seed traders

Like seed producers, local traders consider that, for now, the most popular and in-demand forage seed in the northern Lao market is Ruzi grass. Sales in total can reach 500 tons/year, it is cheap, works for animal feeding and as well as for selling surpluses, and it is suitable for local conditions given its easy cultivation and maintenance; therefore, they do not anticipate a variety that could surpass its popularity. Other marketed varieties, such as Guinea and Mulato, although resistant to drought and high rainfall and known to maintain high productivity for several years, are less common due to their high price, which affects popularity among small livestock raisers and market availability. In addition, introducing new varieties depends significantly on government decisions and the influence of stakeholders such as national-level research projects and entities.

Private forage seed companies

After COVID-19, companies started adapting higher-value varieties and products to local needs and conditions and adopting innovative production techniques to strengthen their businesses, maintain price competitiveness, and reduce their susceptibility to fluctuations like shipping costs. For example, considering overseas customers, three other *Crotalaria* species (other than the abovementioned Sunn hemp – *Crotalaria juncea*) are being tested in trials, and their characteristics include suitability for

intercropping with cassava or sugarcane and high nitrogen fixation. Other species include lablab bean (*Lablab purpureus*) and butterfly pea (*Clitoria ternatea*). Butterfly pea may suit smallholders because it can produce a constant income flow. Regarding cover crops, there is growing interest in testing *Crotalaria ochroleuca*, which has been shown to have a high protein content and lesser toxicity than Sunn hemp. Under optimal production conditions, it can produce high biomass and be cheaper than other forage crops.

However, regional markets and smallholder demand are still dominated by Ruzi grass because it is a cheap and palatable grass, even though it doesn't have good drought tolerance. Besides, some farmers in Laos and Thailand are refusing to grow Mulatto for seed production since recently it is facing competition with cassava, with farmers switching to cassava production because of higher rentability.

Research and development national institutions

The actors interviewed in this category identify three main grass species used among smallholders in northern Laos: Ruzi, Napier (for cut-and-carry systems) and Guinea Grass. However, these grasses present significant challenges due to their high susceptibility to drought: during dry season, when feed sources become scares, cattle raisers continue to rely on them despite their reduced biomass production. To supplement the shortage, they combine these species with native species such as broom grass (*Thysanolaena maxima*) or byproducts such as banana stems. Other potential feed byproducts, such as maize residues, are often underutilized due to a lack of knowledge about their suitability for livestock feed or how to process it. As one participant noted, maize is primarily cultivated for sale (as a cash crop), while residues sometimes are left in the fields as fertilizer.

Smallholders also use stylo (*Stylosanthes guianensis*), though less proportion. Adoption of this legume is not widespread because of its low germination rate and its reliance on cut-and-carry systems, which require either labor or machinery, both of which are scarce in small-scale production systems. Towards central Laos, forage such as *Panicum maximum*, *Paspalum*, and Pangola are more commonly used.

In the case of Mulatto II, while its commercial seed price has recently risen, indicating growing demand, seed production in Laos is primarily geared toward export. The seeds are sent to Thailand, where they are cleaned, processed, and packaged before being returned to Laos for distribution.

3.1.2. Force #2: New entrants (barriers)

A. Access to distribution networks

Smallholder forage seed producers

Farmers work individually and are largely fragmented, making it difficult for them to improve their price negotiation conditions. It also makes it difficult to create efficient distribution networks that rely on economies of scale and reduce transaction costs for new entrants in the sector. Some isolated collaborative work efforts are described, mainly to share information on forage seed cultivation techniques and forage management. Although not structured, these collaborative spaces are an opportunity for improvement that could boost pasture and seed production, product quality, and market competitiveness for livestock products.

Among the aspirations of forage seed producers is to improve their participation conditions in the Ruzi grass seed market. Farmers would like to establish contracts with clients or companies that guarantee continuous purchases. To do this, collaborative work becomes more important to ensure compliance with seed quality standards and to comply with sales contracts. This highlights the relevance of establishing formal agreements with companies and regular clients. In this way, marketing would offer them stable prices, and they would have the necessary support to export seeds to other countries.

Nonetheless, past experiences with contract farming for selling forage seeds have not been successful. Low predetermined prices, scarce access to resources and limited land to meet the volume demanded are the main concerns when signing farm contracts. Therefore, in reality, many farmers prefer to work more informally. These informal commercial agreements allow for greater transaction flexibility, where farmers sell directly to customers without pre-established contracts, without meeting a determined volume or setting a price.

Local forage seed traders

Traders want to improve and diversify their operations. They are looking to establish seed stores, improve storage, and acquire delivery trucks and sorting machines, reflecting their intention to expand and modernize. They are also interested in projects introducing flood- and drought-resistant forage seed varieties adapted to local needs. They also want support from companies and projects to access improved varieties of Ruzi grass, implement forage seed collection programs, and receive support through related development programs.

Private forage seed companies

The Cambodian startup company, with domestic and regional markets making up a significant part of its niche, affirms to face competition from governments and development projects because, through subsidies or donations, they provide free seeds to producers. This hinders the creation of an environment in which smallholders have a willingness to pay for forage seeds, challenging the positioning of their products in these markets. In addition, also the growing number of unofficial traders on Facebook, who offer the cheapest seeds but without a quality guarantee, make it difficult to reach a higher market share.

Research and development national institutions

The forage seed distribution networks built by the research and development sector participants, who focus on providing access to small producers, are based on the farmer-to-farmer model. One of the interviewees mentioned: *"The project can train only 10 houses, 10 farmers. And when they get the seeds, some of them sell, and some give them to their neighbors or their relatives. It means that the project can expand automatically* (R&D's interviewee, personal communication, July 23, 2024).

B. Access to necessary inputs, services or knowledge

Smallholder forage seed producers

The results reveal a limited presence of institutional support and formal projects focused on agricultural development. Most farmers mentioned the District Agriculture and Forestry Office as the main source of technical advice, but they highlighted the absence of recent or individualized technical assistance. Some remember specific projects from the past, such as one in 1998 that promoted the cultivation of pastures for livestock feed, although this project lacked continuity. Many farmers emphasize the need for more specific training and support programs, pointing out that, beyond occasional technical advice, they have not received significant assistance. Promotional programs should also emphasize livestock farming as a commercial activity. Regarding access to financial mechanisms, the Lao Development Bank is the only actor mentioned, although its impact on forage cultivation is indirect, as it offers loans for animal purchases.

Regarding the use and cultivation of forages for livestock feeding, a notable lack of training and knowledge exists among the farmers interviewed. On the one hand, most did not receive any formal training on sowing or harvesting methods, so they rely on their empirical methods (trial and error) and what they learn through social media. Although the Department of Agriculture is mentioned as an actor that provides seeds and basic notions on forage management, the efforts lack structured support from local authorities. In addition, lack of knowledge about mixing the seeds of different varieties/species

and its benefits is widespread, which hinders the adoption of more diversified and sustainable agricultural practices. Some farmers have received seeds to experiment with but without detailed information, reflecting a limited knowledge transfer.

Local forage seed traders

Local traders work as intermediaries to supply forage seeds when a project requires them. Currently, there exists a project aimed at livestock productivity, which requires forage seeds to be delivered to farmers, encouraging the expansion of pastures areas. On the other hand, they mention that commercial units participate in establishing prices for these initiatives, but not all traders have received this support. Local traders stated that there is no support from the government in their commercial activities. Hence, depending on the context, there is a varying degree of involvement of traders in projects.

C. Production or commercialization difficulties

Smallholder forage seed producers

Lack of labor, adverse weather conditions, poor quality of forage seeds, and technical and economic limitations are the main challenges for livestock feeding and seed sales for forage production. The shortage of labor delays agricultural activities because there are not enough workers to plant or harvest and increases the production costs. Adverse weather impacts seed quality, as extreme cold, lack of rain, and increased pests (such as ants) affect pasture germination rate and growth, forcing farmers to replant. The low quality of seeds hinders the proper development of pastures, as many farmers save seeds for replanting or do not have quality guarantees. Besides, there are significant needs in terms of technical training, technological innovation (for production and marketing), development of infrastructure for harvesting and storage, and climate adaptation strategies.

Local forage seed traders

Seed storage and conservation infrastructure, the limited availability of machinery and equipment for seed classification to ensure quality and improve product presentation, the variability of seed supply and quality, and the increase in online marketing media are the main limitations for local traders. The impacts reflect reduced operational efficiency and more significant difficulties in competing with other traders in the market. The variability in seed supply and quality causes supply problems and losses in profit margins, since seed drying is not homogeneous and generates variation in the volume purchased. Meanwhile, online sales on social networks or platforms have begun to replace physical marketing channels, and traditional businesses see their sales reduced. Local traders generally do not have a consolidated marketing strategy for promoting their products. However, with the rise of digital platforms, they have turned to Facebook, but most have not yet achieved great popularity.

Price volatility is another constant concern, especially when selling Ruzi grass seeds. Over the past five years, the price of this seed has dropped constantly as more and more farmers started to grow it. The volatility is such that the selling price is less than the purchase price within just a few weeks, leading to considerable financial losses and uncertainty among local traders.

Private forage seed companies

As noted by the interviewees, one of the main challenges for private companies working with farmers for producing seeds, is to transform traditional production practices and to introduce science-based practices in cultivating and harvesting forage seeds. Still, very few farmers working with one of the companies in Thailand apply any fertilizers or other methods to improve soil fertility. Technical government assistance is insufficient, and sometimes, farmers base their practices on advice provided by salespeople in the agro-shops, which may or may not be good recommendations. To overcome this

challenge, forage seed companies could collaborate to offer technical assistance to farmers, producing innovative seed production techniques, and increasing the supply and quality of forage seeds.

Forage seed production demands suitable agronomic conditions, including sufficient rainfall and adequate soil type, and available infrastructure to process and transport the seeds. Thai companies have set up several trials in the southern part of the country's, along the Peninsula, to find the best place to produce seeds without the prolonged drought in the north. As this region is home to palm oil and rubber plantations, Thai forage seed companies started negotiating with oil palm and rubber companies to share farmers´ land for intercropping, harnessing fertilizer savings and improving soil conditions by growing forage species for seed production. In this sense, expanding the forage seed areas to meet the growing worldwide demand faces competition with cash crops.

Even though the interviewees agree they do not to compete with forage seed companies in Brazil or Mexico, they highlighted an unexplored topic: the differences in production efficiencies, suitability and market structures between regions for seed production. As they noted, both LATAM and SEA companies produce the same species, but there is still a lack of understanding about why Latin American enterprises can produce certain varieties at a lower cost compared to their Southeast Asian counterpart, and vice versa.

Recent projects have tried to teach farmers how to produce their own seeds. Still, interviewees' question if farmers will be able to maintain the quality of seeds, especially when environmental conditions are not suitable everywhere. Even independently of these conditions, farmers will face a decline in seed purity and quality over time, leading to increased dependence on fertilizers. They will need regular replenishment with high-quality seeds, and without appropriate seed cleaning and processing, seeds can be affected by soil-borne diseases. This suggests that the profitability and long-term sustainability of this practice remains open for discussion, considering their primary objective is usually livestock production. As noted by the interviewee, a strategy like this can produce effects contrary to adopting improved pastures, as farmers cannot wholly meet the necessary conditions for seed production that guarantee quality.

D. Government policies or normative framework

Local forage seed traders

Various formal and informal practices are reflected in the payment of taxes, licensing for commercial activity, and fiscal obligations for business operations for seed marketing. Larger stores comply with regulatory requirements, while informal traders do not, usually without any difficulty continuing their marketing activities.

Private forage seed companies

Relationships with government authorities and the normative framework have been challenging for private forage seed companies in Thailand. Even after going through the phytosanitary measures, pest management, and plant quarantine required by regulation (such as pest risk analysis-PRA, overseen by MAF and its divisions like the PPRDO), some cases can take more than five years to get national permissions to export seeds. Closing deals with international customers is harder under this condition. Even then, accomplishing the regulations is not a guarantee for exporting overseas, and interviewees affirm that a successful permit process depends on ¨*having good luck, paying a lot of unofficial fees, or relying on someone well connected*¨. The language and cultural idiosyncrasies are also challenging when talking with local authorities. Collaborating with other seed companies, either forages or other crops, is not as easy for them because, according to their words, ¨*other seed companies are far away from them, making it difficult to attend meetings*¨.

Regarding the experiences of the companies in regional seed trading, the different regulatory and customs frameworks are not harmonized, and nobody seems to know precisely how it works. Companies need to fulfill a lot of paperwork, and the flow of processed products mainly comes in one direction, from Thailand to Cambodia. Even in some cases, '*special services needed like transferring money between countries is a headache'*, as interviewed noted.

In addition, when the startup company started introducing the varieties to produce seed in Cambodia, it took three years for it to be registered, because the national framework did not include a category of cover crops or forages. Currently, the company is working with the government to establish or adapt the quality control system for forage and cover crops seed production.

Research and development national institutions

Introducing new forage varieties to Laos involves two major steps. The first is researching and assessing the variety's suitable environmental conditions and productivity. Bringing new accessions into the country is relatively straightforward, as it is done in collaboration with research organizations, one of them based in Laos and the other in Thailand. Once quarantine requirements are fulfilled, the process can be completed within one or two days. Initial testing is conducted at various research stations over several years. These trials evaluate the performance of the forage under different soil conditions, climate variability, seasonal changes, among other variables. Once the most promising materials have been identified, they are tested on farms to assess their productivity in terms of feed and seed production. At this stage, farmers play a key role in deciding which materials are most suitable for distribution, through the Farmer Trials. Farmers are also provided with training, enabling them to produce seeds independently and achieve self-sufficiency.

The second step focuses on evaluating seed quality, developing branding if it is intended for production, and establishing connections to value chains and marketing networks. These activities aim to ensure the new forage varieties are not only suitable for local conditions but also integrated into sustainable and market-oriented systems.

E. Capital requirements

Private forage seed companies

Investments in processing equipment are aligned with the cleaning standards and germination levels demanded by international markets. Thai companies reported making significant investments to ensure the highest seed standard, meeting the requirements of customers in in Europa, America, Australia and other regions. They noted that only few companies in Thailand are involved in producing and exporting the forage seeds varieties that they do, which has required them to make considerable efforts to adapt seed production techniques. According to them, these efforts are further challenged by finding skilled huma capital.

Due to their limited interest in serving domestic and Southeast Asian (SEA) markets—particularly smallholders who are highly price-sensitive—these companies appear to favor offering lower-quality forage seeds to these markets. This trend reinforces barriers to adopting improved forage varieties in these regions, as accessibility to quality seeds remains a significant challenge and the imported ones are expensive. One interviewee explained

> "*If you're just dealing with local market, then you probably don't need to buy the high-end seed cleaning equipment. You don't. It doesn't really matter if there's a little bit of straw, a little bit of light seed, or uh, maybe even a little bit of weed seed in there, because it's likely that those, you're just returning it to the fields it came from.*" (Private seed company's interviewee, personal communication, August 2, 2024).

3.1.3. Force #3. Threats (substitutes)

A. Emergence of new substitutes (hybrid forage varieties)

Local forage seed traders

Opinions about hybrid forage varieties among local traders are divided. Some claim to have never heard of these forage varieties before, and others have. Based on what they have heard about the results of hybrid forage varieties in terms of adaptation to local conditions and productivity, livestock raisers would be willing to use them. Therefore, there is an open attitude to innovation as long as the new options improve the farm's performance.

Private forage seed companies

A forage species mentioned by one of the Thai companies with commercial potential is butterfly pea (*Clitoria ternatea)*. In the SEA region, it seems that no rigorous selection works were done with it, despite its high potential for forage production, given its high tolerance to poor soils and dry conditions. Main breeding efforts were made in Australia, but did not go beyond mixing some of the best accessions from earlier trials. However, the Thai company has not started to trial it, since it hasn't received the import permission from the Thai government yet, which is required by the gene bank that keeps the accessions.

Mulato II performs very well in terms of biomass production but, unfortunately, cannot produce the high seed yields that Ruzi grass does, which is why despite its poor adaptation, it is still popular. The same is the case for *Paspalum* varieties. The Cayman and Cobra trials showed that despite their adaptability and high forage yield, seed production in Thailand was low, with too many empty seeds, and farmers did not like it because of the cleaning processes, eliminating lightweight seeds.

Ruzi grass still has the highest potential because it is easy to grow under the region's topographic and environmental conditions, can be mixed with legumes to reduce the need for fertilizers, and is suitable for sandy terraces that are not prone to flooding and with water access during the dry season. However, its production could be risky due to high water and fertilizer use and high management maintenance costs.

Research and development national institutions

The introduction of improved forage varieties in Laos began around 1995. Since then, more than 500 varieties have been tested, within nine have been selected for further development, as a participant noted. For these new varieties achieve scaling up, benefit smallholders, and effectively compete with Ruzi grass, the must meet the following:

A. ease to reproduction: these varieties must be easy for farmers to reproduce, ensuring self-sufficiency. This requires a thorough evaluation of the seed production potential in the region;

B. affordability: during the initial phases of dissemination, smallholders often have little to none willingness to pay for seeds. Therefore, the seed must be cheap, which imposes significant limitations on importing these materials;

C. simplicity of management: the varieties should not require highly technical management, like Ruzi grass, to deliver favorable results in both livestock yields and seed production;

D. producer training: there must be substantial efforts to train farmers, as they often struggle to distinguish between different varieties. As one interviewee explained: *'maybe the farmers don't understand about the hybrid variety [...], maybe the farmer, they cannot separate between the hybrid and Ruzi grass because the leaves are quite similar*' (R&D's interviewee, personal communication, July 22, 2024).

3.1.4. Force #4. Buyers (bargaining power)

A. Buyer information

Smallholder forage seed producers

Farmers in northern Laos primarily supply raw forage seeds in domestic or foreign markets. Sales are mainly to nearby neighbors, family members, and local traders who export the seeds. Traders of Ruzi grass are usually buyers from the Phaxai district or nearby villages of the Phoukoud district, but farmers are generally unclear about the final destination of their production. One case identifies the buyer as a Thai company selling the Ruzi grass seed in international markets.

Local forage seed traders

While interviewees claim that men and women have equal access to seeds, some traders indicate that most forage seed buyers are men. This is due to the division of labor, where animal husbandry is considered predominantly male work. It may explain why women buy seeds less frequently and, when they do, are often accompanied by their husbands. The physical task of moving seeds is a traditionally male tasks due to the physical strength demanded, which reinforces this idea.

Private forage seed companies

The Cambodian startup identified two primary channels for commercializing their seeds: 1) medium-to-large agribusiness, which have clear production goals and specific seed requirements, and 2) donor-funded projects that focus on distributing seeds to smallholders. For example, in the first channel, a Vietnamese coffee plantation company is interested in using Stylo, not as a forage crop, but as a cover crop to plant in row within coffee. Their goal is to enhance soil carbon sequestration and make their coffee production more sustainable. However, the seeds haven't been yet registered in Vietnam, and the registration process is consuming time and resources. In the second channel, the company has collaborated on projects with organizations such as USAID, CIRAD, or FAO.

While there seems to be a lack of clarity forage seed buyers in the domestic or SEA markets, representatives from two forage seed companies noted that their seeds often end up with Thailand's Department of Agriculture (DOA), though not necessarily purchased directly from them. They explained that the Thai government operates a subsidy system to give the farmers free seeds. However, counterproductive bidding practices, such as prioritizing the cheapest and low-quality seeds to get a trade margin, have hampered efforts to benefit farmers.

B. Price-sensitivity

Smallholder forage seed producers

Most farmers prefer immediate cash payments at the time of purchase as a mandatory condition for seed sale. Some are willing to accept later payments, but only under certain conditions, such as knowing and trusting the buyer. Credit payments are rare and depend on trust between the farmer and the buyer. Although some buyers have begun to ask for deferred payments, this practice remains limited. In short, cash payment is the norm due to its immediacy and ease, while credit payments are exceptional and more common in trusting relationships.

3.1.5. Force #5. Suppliers (bargaining power)

A. Commercial agreements

Local forage seed traders

A way of marketing forage seeds consists of collecting them from villagers for export to neighboring countries such as Thailand and Cambodia, where the seeds are cleaned and processed for re-export to international markets or back to Laos. Some traders in this line manage their seed supply through contracts with farmers to control production, avoiding an oversupply as occurs in the case of Ruzi grass, and guarantee the supply's stability throughout the year at a stable price. This method applies to varieties such as Guinea and Mulato. Commercial agreements facilitate the conditions for sowing these varieties, as traders lend a quantity of foundation seeds (i.e. pure seeds derived from *breeder seeds*, that serves as the source material for producing certified or commercial seeds) to farmers for production, and at the time of the transaction, the volume of seeds lent is deducted from the total purchase value.

Private forage seed companies

Forage seed production in Thailand was introduced in 1974. The pioneering company started introducing machinery and supported by the seed production stations of the national research institute; however, the most cost-efficient and less risky way so far is through farming contracts. Farmers' contracts usually offer them a sort of foundation seed, which is discounted from the total purchase volume. The seed price and volume are settled in the contract. Some companies in Thailand include training into the contract agreement, especially about topics like harvesting methods and timing and drying seeds, and even provide seed producers with small seed cleaning machinery. However, agreements with Laotian farmers do not include these benefits.

Agreeing on farmers' contract conditions could involve different actors enforcing each country's normative labor issues. Then, signing the contracts, setting the price, and payment methods, among others, can be done directly between the coordinator and farmer in Laos. Meanwhile in Cambodia, local authorities, such as the commune chief or the provincial department of agriculture, participate as witnesses and co-sign the commercial agreement using the *pakras*[1] issued by the Ministry of Labor and Vocational Training (MLVT) and the Cambodian Labor Law as guidelines.

Private companies can work with farmer networks of up to 5,000-7,000 farmers in Thailand. The most efficient way to deal with them is through a coordinator, a person in charge of management contracts, payments to farmers, collecting seeds, orders, and volumes, expanding the farmer network, guaranteeing fairly pure cultivars, and acting as a communication channel between farmers and the company. In the past, coordinators were incentivized to expand the groups of seed farmers by offering a sale commission per kg of sold seed. However, this strategy did not work because some started paying the farmers way less than the company's seed buying price.

Common challenges working with farmers in this way have been related to training and selecting them to work with, since the companies rely strongly on farmers' practices to guarantee pure cultivars (mainly to avoid mixing seeds with other *Crotalaria* varieties) and quality seed. Building a trusting relationship among the company, coordinator, and farmers in the network has taken time and resources. Complying with contract agreements is another challenge. Forage seeds of varieties like Mulatto II have gained popularity, while the number of unofficial traders has increased, increasing competition. Since the price is settled according to market dynamics, traders can easily buy the seeds by offering slightly higher prices than the settled ones, creating a supply shortage for official companies. As an answer to quality issues or non-compliance with commercial agreements, companies stopped working with the farmers involved.

[1]. Pakras refers to normative or governance instruments issued by the government, such as official proclamations or ministerial decisions.

3.2. Dual-purpose hybrid maize industry

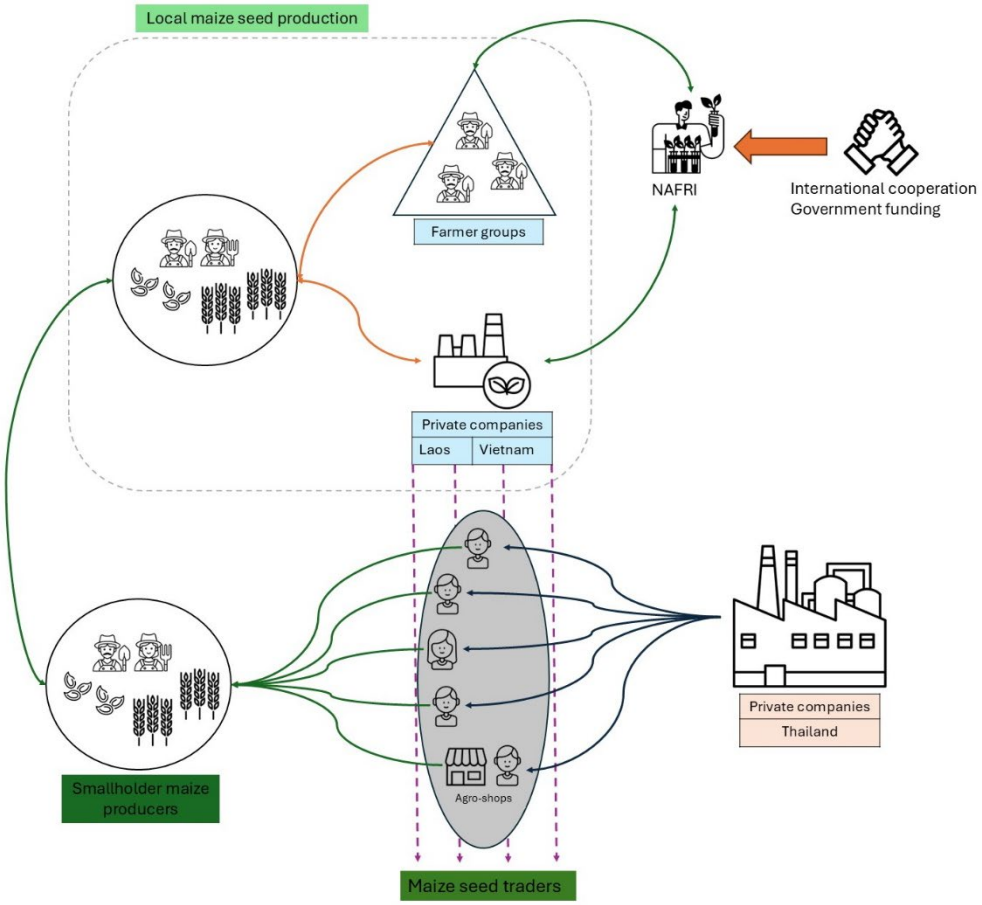

Figure 3. Dual-purpose hybrid maize seed supply map from Northern Laos.

3.2.1. Force #1. Industry competitors (rivalry)

A. Industry basic conditions

Research and development national institutions

The production of hybrid maize seeds to meet the demand in Northern Laos is primarily carried out by large companies in Thailand and Vietnam. To a lesser extent, hybrid maize seeds production is also conducted by NAFRI, which supplies northern provinces such as XKH, LPB, Oudomxay and Xayaboury. NAFRI produces Vietnamese hybrid yellow maize F1, LVN10, for which it holds production rights from the neighboring country. However, NAFRI´s production capacity remains limited. Its annual seed production is estimated at 300 tons, while the country imports approximately 2,000 tons per year.

NAFRI utilizes 2-3 hectares to produce these maize seeds, which are then distributed to farmers either free of charge or at a significantly lower price than the market price. To support the production of hybrid maize varieties, NAFRI collaborates with two farmer groups – one in XKH province and the other in Oudomxay province – as well as with two private companies, one based in Laos and the other in Vietnam. However, after COVID-19 pandemic, production through one of the farmer groups was suspended due to cash flows center's limitations. Despite this, the farmer group continues to produce independently.

The purchase price of unprocessed F1 hybrid seeds produced y NAFRI through farmer groups ranges between LAK 15,00020,000 per kilogram. The retails price for farmers is between LAK 70,000-80,000 per kilogram, while the wholesale price for private companies is approximately LAK 90,000 per kilogram. These companies, with bigger production capacity, processing, and marketing, work under an agreement with NAFRI that allocates the profit margin from seed sales between the parties. Typically, this margin is split 20-30% for NAFRI and 80% for the companies.

In some cases, private companies establish seed production agreements with farmer groups. Under these arrangements, companies provide F1 maize seeds to farmers as a loan, which is deducted from the total sales volume to the company. The market price set by the companies for these seeds ranges from LAK 90,000-110,000 per kilogram. However, Laos-based NAFRI´s partner company faced labor shortages for hybrid maize seed production, prompting a shift to a business model focused solely on commercialization. This adjustment has also increased reliance on imported seeds from Vietnam.

To expand the center's production capacity, plans are underway to reactivate partnerships with farmer groups and to establish new collaborations in XKH Province. Thus far, the center has initiated seed production trials on half a hectare at one of its research stations in Vientiane. Nevertheless, government funding for both seed improvement and production remains limited. To carry out its functions, the center collaborates with international development entities such as CIMMYT, as well as organizations from Australia and China, including the Institute of Agricultural Environment and Resources at the Yunnan Academy of Agricultural Science (YAAS).

Local maize seed traders

According to participants in this category, the highest maize seed sales are reported in November, likely driven by the needs of pig and poultry farms. In some cases, supply does not meet demand during this period. Additionally, small-scale traders do not implement promotional strategies for new varieties or their products. Instead, they rely on the marketing networks they have established with their clients.

Interviewees noted that maize seed prices have increased over the past five years, possibly due to inflationary pressures. In 2020, CP hybrid seeds were sold at prices ranging between LAK 45,000–50,000 per kilogram. By 2024, these prices have risen significantly, now ranging between LAK 120,000–140,000 per kilogram

B. Product differences

Research and development national institutions

The LVN10 variety produced by NAFRI is primarily used in the aquaculture industry. Although it delivers favorable results and can also be used as forage, its popularity among farmers remains low compared to the wide range of Thai seed options, with CP being the market leader. By 2025, NAFRI aims to include 2–3 hybrid maize varieties in its seed catalog. One of these varieties is being developed in collaboration with CIMMYT in response to a request from the Department of Agriculture (DOA) for new maize varieties that can also be used as forage and livestock feed.

As of the time of this study, progress includes the implementation of multi-location trials and farmer trials. The key traits being developed for this variety include improvements in yield, adaptation to the climatic conditions typical of northern Laos—particularly the uplands of Xiengkhouang (XKH), Oudomxay, and Luang Prabang (LPB) provinces, where maize production is highest—and drought tolerance, given that maize in these regions is typically grown under rainfed conditions. The goal is for the new variety to compete with leading options from CP and Asia-Pacific.

Although the primary focus of this variety is grain production, evaluations have been conducted to assess its performance for silage use. The inbred line for this variety originates from Thailand, and while biomass production results are positive, further studies are needed to evaluate protein content and

other nutritional quality variables. However, demand for maize as an input for silage production remains low among small- and medium-scale livestock farmers. According to the participants, the only significant user of maize for silage is the Vietnamese-owned dairy company VinaMilk. This company manages approximately 500 hectares in XKH Province, where maize is grown to produce silage for their 5,000 dairy cows used in milk production.

The participants highlighted that the approach taken by NAFRI differs from that of companies like CP when testing a new variety. CP typically provides farmers with a single variety to test without offering multiple options for comparison. In contrast, NAFRI allows farmers to evaluate the new variety alongside others to better assess performance. As the interviewee explained:

> *"They just, like through their network, they just asked the farmer, 'Okay, you grow this variety in the roadside and put aside this new variety of CP,' and when the farmer goes and sees [...] they decide if it is good or not, but they don't compare it with other varieties."* (R&D's interviewee, September 2, 2024).

The main maize varieties used in the region are led by CP508, which is estimated to account for more than 40% of the total maize cultivation area. This variety is often mixed with others. Other popular options include CP640, CP26, CP888, among others.

Local maize seed traders

According to the interviewed maize seed traders, the most popular maize varieties include CP640, and other varieties produced by CP. Traders obtain these seeds through a CP sales representative located in Kham District, Xiengkhouang (XKH) Province, as well as from other villages within Phoukoud District.

Local authorities

As noted by other stakeholders, representatives of local authorities also identify CP508 and CP640 as the most commonly used maize varieties among producers. These varieties are imported from Thailand and are favored by farmers due to their high yield.

C. Industry growth

Research and development national institutions

The development of hybrid maize varieties, as well as other seeds such as rice and certain vegetables, is aligned with multiple political efforts, including monetary policies aimed at stabilizing inflation. By enhancing the country's seed production capacity, the government aims to reduce seed imports, thereby contributing to inflation control. Additionally, efforts to develop the livestock sector remain a government priority, with the expectation that these hybrid maize varieties can also be utilized as livestock feed.

However, the current demand for maize as forage is limited primarily to large specialized dairy companies, such as VinaMilk. In the future, the variety under development by NAFRI is expected to serve this customer segment. Domestically, demand remains high, with approximately 2,000 tons of maize seeds imported annually, highlighting significant opportunities, according to participants. Other potential uses for these hybrid varieties include the swine and poultry sectors.

Local maize seed traders

The commercialization opportunities for hybrid maize seeds are primarily centered around varieties that can increase yield, according to the interviewees. However, achieving this requires extended and continuous technical assistance, as well as ensuring that farmers receive high-quality seeds.

Local authorities

The maize production industry has the potential to expand within the country, driven by increasing demand for livestock feed, as noted by interviewees. This trend is reflected in the growing number of maize seed imports by traders in the study area since 2021.

D. Diversity of competitors

Research and development national institutions

Charoen Pokphand Seed Company Limited (CP) and Limagrain Asia-Pacific are the two largest companies competing with NAFRI to produce and supply hybrid maize seeds in northern Laos. Both companies are headquartered in Thailand and have a strong presence in the Lao market, particularly in border areas and provinces such as Oudomxay, Xayabury, and Xiengkhouang (XKH).

CP, in particular, establishes contracts with farmers, providing them with guarantees for its products. The company has distribution channels in all provinces of Laos, ensuring easy access to its seeds. As of this study, CP has approximately four hybrid maize varieties well-positioned in the market, enjoying significant popularity among farmers. Additionally, the company introduces new varieties to the market annually. The company's distribution agent plays a critical role in this process. The agent supplies farmers with the seeds CP intends to launch in the market, allowing them to test the new varieties. The agent is also responsible for providing feedback to the company's headquarters, which then decides which varieties to further develop and commercialize

3.2.2. Force #2. New entrants (barriers)

A. Access to distribution networks

Research and development national institutions

After genetic adaptation and multiple farmer trials over several seasons and years, the selected variety is released for commercial production. NAFRI initiates a pre-selling phase, providing seeds to a number of farmers or farmer groups to begin scaling and dissemination. However, the scaling process is slow due to limitations in seed production. While NAFRI collaborates with some producers for seed production, the supply is insufficient to meet overall demand. Meanwhile, NAFRI's agreement with private companies also includes providing technical training to the company's human resources. In turn, the company assumes responsibility for seed production, processing, and marketing.

According to interviewees, other seed distribution channels in northern Laos include large agro-shops. One prominent agro-shop, equipped with storage facilities, directly imports around 1,000 tons of seed annually from Vietnam. Additionally, leaders of certain farmer groups act as distributors, either as middlemen or by collectively negotiating better wholesale prices. Digital channels and social media platforms like Facebook and TikTok are not typically used for direct purchases of hybrid maize seeds but are utilized for promoting available varieties.

B. Production or commercialization difficulties

Research and development national institutions

One of the primary limitations faced by NAFRI in hybrid maize seed production is its production and marketing capacity. For the variety currently under development, a key risk is ensuring sufficient production volume while reducing distribution costs to better compete with CP varieties. NAFRI's distribution strategy relies on the networks of its Vietnamese and Lao partners companies.

As mentioned earlier, maize seed production through one farmer group was suspended after COVID-19. This production model, which has been used since around 2010, involved NAFRI providing training and capacity building to farmers. However, the center requires cash flows to purchase seeds from farmers, but delays in wholesale payments from commercial groups to NAFRI have caused cash flow constraints, preventing immediate payment to farmers.

For private companies, labor shortages are a significant constraint in maize seed production. NAFRI provides training and technical skills to company staff, enabling them to manage production, processing, and marketing. However, limited availability of NAFRI professionals for continuous follow-up means the company's personnel are responsible for overseeing planting to harvest. One interviewee also noted that the company seems to be facing challenges related to business profitability.

Local maize seed traders

According to interviewees, hybrid maize seed commercialization has been affected by the country's high inflation rates, as maize cultivation heavily depends on imported seeds.

Local authorities

Local authorities identified soil degradation as the primary limitation affecting maize cultivation. This has led to a considerable decline in yields. Furthermore, as farmers rely heavily on imported seeds for cultivation, rising costs due to inflation have increased their production costs.

3.2.3. Force #4. Buyers (bargaining power)

A. Buyer information

Research and development national institutions

Some producers, especially those with limited investment capacity in provinces like Xiengkhouang (XKH) and Oudomxay, prefer the LVN10 variety. With this variety, even without fertilizer application, weed control, or other management practices, they can achieve yields of around 3 tons per hectare. In comparison, newer CP varieties may yield less than 1 ton per hectare without proper management. Under good management, LVN10 can yield up to 6 tons per hectare, while hybrid varieties can exceed 10 tons per hectare.

Local maice seed traders

The main clients of interviewed traders include poultry and pig farms, as well as agro-shops. Some traders also sell seeds at the Thailand border to Thai traders who purchase seeds produced in Laos.

B. Price-sensitivity

Research and development national institutions

In some areas of Xiengkhouang province, price sensitivity for seeds is not a significant limitation for farmers. Despite the higher cost of CP hybrid varieties compared to LVN10, farmers often prefer hybrids due to their higher yields. The price of CP varieties can reach around LAK 120,000 per kilogram, compared to LAK 70,000–90,000 per kilogram for LVN10. This preference is influenced by the purchasing power of individual farmers and their capacity to invest in proper crop management. Additionally, their choice is often shaped by the marketing networks to which they belong.

4. Principal remarks

The main seeds produced by smallholder forage seed producers in northern Laos are Ruzi grass and Napier grass. These seeds are primarily used to supply the producers' own livestock systems and, secondly, for commercialization through traders who sell them to forage seed companies in Thailand and Cambodia. These companies, in turn, re-export the seeds to their target markets, both within Southeast Asia and internationally. This dynamic has positioned northern Laos as a key point in the operational chain of forage seed companies, driving the growth of the seed production industry and attracting more smallholder forage seed producers and informal traders to the business.

However, smallholders who initially saw the commercialization of Ruzi grass seeds as an opportunity to diversify their income now face a significant drop in seed prices due to an oversupply. The production of Ruzi in the region has been sustained primarily through traditional methods, suggesting that the surplus is more closely linked to the expansion of cultivated areas rather than improvements in production efficiency.

The expansion of pasture cultivation areas is also closely tied to the growth of the beef market. The increasing demand for beef products from neighboring countries like China and Vietnam, along with trade agreements signed between these nations, has been a key factor driving interest in modernizing Laos' livestock industry. To intensify livestock systems in Laos and maximize the economic benefits for smallholders, one of the biggest challenges lies in displacing Ruzi grass from its dominant position in cattle/livestock diets.

Ruzi Grass, along with other commonly used grasses in the region, such as Napier and Guinea Grass, has significant limitations. These grasses are not drought-tolerant and have nutritional deficiencies. Despite these disadvantages, their dominance persists for several reasons:

1. Low capital intensity: Farmers invest minimal resources in time, management, labor, fertilization, or mechanization to both feed their livestock and produce Ruzi seeds.
2. Favorable narrative: A widely held perception, primarily promoted by traders, claims that Ruzi grass is well-suited to local agroecological conditions, likely attributed to its high seed production yields.
3. Accessibility and affordability: Ruzi seeds are readily available in local markets at significantly lower prices compared to other complementary forages seeds.

Farmers recognize the limitations of these forage varieties and are keen to adopt other varieties along with innovative feeding strategies, especially to cope with drought and participate in regional beef export markets. However, access to forage substitutes is mainly due to development projects. Many stakeholders agree that smallholders have little to no willingness to pay for new forage varieties. Thus, the dissemination of technological innovations in livestock feeding relies heavily on providing access to resources – such as inputs and financing – through public sector investments or international cooperation. This perspective reinforces the idea that small-farmers are not yet seen as a viable standalone market, without a demand to meet.

The niche market for forage companies in the region focuses on larger regional or international clients, or indirectly on small producers through public development programs or international cooperation. Companies have identified alternative cover crops, such as *Crotalaria ochroleuca* or Crotalaria *juncea*, which could benefit small producers by being suitable for intercropping with cash crops. These varieties offer high nitrogen fixation rates and elevated protein content, and under optimal conditions can produce cheaper biomass. However, the availability of seeds for these varieties remains limited, relying on smuggling seeds, high prices, and much of the supply consists of seed seconds-grade.

Development projects often aim to make cattle smallholders self-sufficient in forage seed production. As seen with Ruzi grass in its early stages, surplus seeds can eventually be sold, creating additional income streams. Opinions on this model are divided. On the one hand, leveraging community-based networks for farmer-to-farmer distribution, which have historically supported their production models, has proven effective in scaling adoption and enhancing. On the other hand, concerns remain about the long-term sustainability of this model, as foundation seed purity declines over time, increasing reliance on agro-inputs, foundation seed replenishment, leading to increase their production costs.

Forage seed production in the region also faces challenges, not only in identifying species and varieties that best serve livestock performance but also in achieving efficient local seed production. Companies have conducted numerous trials to adapt seed production methods from other regions to local conditions. Often, the areas most suited for seed production overlap with regions dedicated to cash crops. This overlap requires developed coordination models or production agreements between forage seed companies and large agricultural conglomerates, such as those involved in palm oil and sugarcane. Additionally, developing robust supply networks has demanded significant investments in trials, training, and building trust with local smallholder producers, alongside managing losses from non-compliance or poor technical practices. Nonetheless, small producers see commercial agreements with forage seed companies as an opportunity to diversify their income, particularly if they can also use the introduced forage varieties for their livestock systems.

Therefore, to better serve small livestock producers in the region, introducing hybrid forage varieties, in addition to adapting to the area and resisting climatic adversities without compromising their performance, they must address several key factors such as 1) being easily reproducible by producers; together with 2) evaluation of the conditions under which the seed production or propagation are sustainable, considering market structures, agroecological variables, and community-based production models, 3) simplified management for the full development of their productive characteristics, and 4) training, capacity building and dissemination of information among producers. This last point demands coordinated efforts from governments, development projects, traders, smallholder forage seed production and forage seeds companies. By working together, these stakeholders can create a more robust market strategy to develop and meet the demand for innovative forage varieties in the region.

To successfully develop and scale the production of dual-purpose hybrid maize seeds varieties, it is crucial to enhance production capacity, establish robust local distribution networks, and strengthen marketing strategies. These efforts are particularly essential in order to align with government efforts for addressing macroeconomic challenges, including hyperinflation, currency depreciation, and substantial public debt growth. However, initiatives by national and international stakeholders face significant barriers to scaling them due to competition with large multinational corporations from the SEA region. These firms possess advanced production capabilities, well-established distribution networks, and highly structured marketing strategies, making market entry challenging for new players.

The presence of alternative seed maize sources from multinational companies intensifies the competitive landscape. These firms often offer superior product availability, even though competitive pricing is not a big threat. However, differentiating the hybrid maize varieties through tailored benefits, such as incentives for local partnerships and unique product characteristics, is critical to mitigating this threat.

Once overcoming the production capacity raised by the current substantial annual demand for maize seeds, other opportunities could consider the potential to develop markets targeting livestock producers. In this sense, partnerships with dairy farms, which already use maize for silage production, present a viable entry point. While small and medium-scale cattle raisers have yet to adopt this practice widely, dairy farms in the region represent a ready market segment where supply agreements could partially meet their seed requirements. However, incentives or other benefits should be offered to encourage these big farms to participate in and secure a customer base in the early stages of scaling.

5. References

Abizaid, C., Coomes, O., & Perrault-Archambault, M. (2016). Seed sharing in Amazonian indigenous rain forest communities: a social network analysis in three Achuar villages, Peru. *Human Ecology, 44,* 577-594. DOI 10.1007/s10745-016-9852-7

Andrade-Piedra, J.L., Almekinders, C., McEwan, M., Kilwinger, F., Mayanja, S., Mulugo, L., Delaquis, E., …, & Thiele, G. (2020). User guide to the toolbox for working with root, tuber, and banana seed systems. RTB User Guide. Lima, Perú: International Potato Center on behalf of CGIAR Research Program on Roots Tuber and Bananas. https://doi.org/10.4160/9789290605577

Ghemawat, P., & Collis, D. (2010). Mapping the business landscape. In Ghemawat, P. (Ed.), Strategy and the business landscape, 3rd ed (pp. 17-43). Prentice Hall

Owusu-Danquah, E., Souksamlane, K., Atieno, M., & Peters, M. (2023). Participatory forage evaluation for integration in mixed crop-livestock-tree systems in upland intensive and highland extensive systems of Lao PDR: Preliminary assessment and results. Cali, Colombia: International Center for Tropical Agriculture. 15 p. https://hdl.handle.net/10568/135115

Porter, M. (2008). The five competitive forces that shape strategy. *Harvard Business Review, 86*(1): 78-93.

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