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Characteristics of Community Seed Schemes for Grains and Legumes

Insights from Northern Nigeria

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Abstract

CONTEXT: Despite the significant roles that intermediary seed systems play in the supply of quality seeds in developing countries, including Africa south of the Sahara, the knowledge gap remains generally substantial regarding the general characteristics and seed quality control performance of intermediary seed systems such as community seed schemes (CSS), which still operate predominantly outside the formal seed systems.

OBJECTIVE: We aim to narrow the knowledge gap on seed production practices implemented by CSS, their economic and technical characteristics, the extent of seed quality control achieved, and potential challenges CSS is facing.

METHODS: Using primary survey data of seed producers of key grains (maize, rice, and sorghum) and legumes (cowpea and soybean) from 380 CSS in Kano state in northern Nigeria, we qualitatively assess origins and drivers of their growth, extent of seed production, relations with upstream actors (breeder and foundation seed providers) and downstream actors (seed buyers), economic structures of their seed production, aspects of quality control measures they engage, and potential roles of external support, such as training on the implementation of these quality control measures.

RESULTS AND CONCLUSIONS: We discovered that many of the interviewed CSS have emerged endogenously, taking up seed production to address the challenges in access to quality seeds in their locality. Their seed production has often grown into viable businesses that have provided potentially significant additions to their incomes. Oftentimes, these CSS implemented some seed quality control measures, including making closer visual checks of seeds, checking germination rates, and bagging/packing seeds, among others. However, fuller seed quality control may be significantly skill-intensive, and most CSS still do not implement many of the recommended measures under some of the intermediary quality assurance standards, such as Quality Declared Seed. Our qualitative assessment suggests that future support for CSS can focus on technical support to raise the ability to engage in broader categories of quality assurance activities in economically viable ways and to improve the awareness and knowledge of different varieties and access to foundation seeds.

SIGNIFICANCE: The quality assurance provided by existing CSS in Nigeria may be relatively limited, particularly in proper maintenance of the seed production field and the quality of original seeds that CSS intend to multiply. Providing external support through training and technical assistance can be an effective way to transform community seed schemes into critical providers of seed quality assurance in the intermediate seed system and to fill gaps in the formal seed system.

Keywords: Community seed schemes, seed quality control, training, grains, legumes, Nigeria

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1 Background

Despite the focus on formal seed quality assurance[1] systems, such as seed certification in many developing countries, recent efforts to support seed systems through integrated seed sector development have increasingly recognized the importance of seed system roles that are less formal but more closely linked with smallholder farmers (e.g., McGuire and Sperling 2016). These less formal systems are also diverse and further separate into "informal systems" or 'farmer-managed systems" and "intermediary seed systems," which often refer to community seed schemes (CSS). Despite the significant roles that intermediary seed systems play in the supply of quality seeds in developing countries, including Africa south of the Sahara (SSA), the knowledge gap on the performance of intermediary seed systems such as CSS remains generally substantial.

We narrow this knowledge gap by providing critical evidence on CSS in Nigeria. We conduct a qualitative assessment of CSS in northern Nigeria using primary survey data from CSS seed producers of key grains (maize, rice, and sorghum) and legumes (cowpea and soybean). We shed light on the economic and technical characteristics and potential challenges of these systems. In so doing, we provide insights into the following crucial research questions across multiple dimensions of CSS characteristics, such as the drivers of their growth, their seed production practices, how these CSS interact with both upstream actors (breeder and foundation seed providers) and downstream actors (seed buyers), the economic structures of their seed production, how they choose which varieties to multiply, which aspects of quality control measures they engage with, their performance in achieving various quality standards, and whether external technical assistance such as training can induce more implementation of these measures. We offer evidence that answers these questions with some quantitative indicators based on reasonably representative CSS data within a confined geography in northern Nigeria.

By focusing on CSS, this paper recognizes intermediary seed systems that may be distinctly different from some of the more informal seed systems. Intermediary seed systems, which are also often referred to as "semi-formal" systems, can be potentially attractive, as they not only differ from the formal system based on certified seeds but also differ from more informal, farmer-managed seed systems (Louwaars et al. 2013; de Boef et al. 2024). CSS are often formed as part of institutions that already exist (e.g., farmer groups, agricultural cooperatives, or self-help groups). Unlike farmers producing seeds in standalone ways through their individual reputation as reliable seed producers, CSS rely on their existing institutional reputations, although some CSS also seek formal accreditation by the public sector as registered seed producers. CSS may benefit from economies of scale in seed production with greater standardized quality than enjoyed by standalone seed producers. Intermediary seed systems can also enjoy more reduced costs of seed production than what would be required under more stringent certified systems. In addition, they can provide ways to supply seeds for varieties that are locally preferred to certified seeds, which may not be readily available for these varieties. At the same time, the intermediary seed system can also suffer from weaknesses in both the formal and the informal seed systems. The costs associated with seed production can still be meaningfully high relative to the informal

[1]This study uses related but distinctively different terms for CSS functions: "seed quality assurance" and "seed quality control." *Seed quality assurance* refers to the function of the seed systems, in which seeds are produced that satisfy the desired quality, such as genetic purity of varieties, physical purity, physiological quality, and other quality parameters. These quality parameters are based on the standards set by the authority under the relevant Seed Laws or those recommended by relevant seed-sector stakeholders. They are made available to buyers in easily identifiable ways that mitigate asymmetric information, such as labeling or other signaling measures (Misra et al. 2023). *Seed quality control*, such as seed certification or more intermediate or informal measures, is a main technical instrument in the process of seed quality assurance. Seed quality control is a measure to make available quality seeds of certain varieties after a systematic process of evaluation.

seed systems, while the overall quality of seeds may still be substantially lower than what would be achieved under the formal system. Recently, a diverse array of donors and nongovernmental organizations (NGOs) have invested considerable efforts in supporting community-based initiatives that assist farmers in farmer seed enterprises, seed production, and seed sharing (Coomes et al. 2015). Seed-producing cooperatives, which often comprise an important part of CSS, have recently accounted for a small but significant share of seed production in West Africa (Access to Seed Index Foundation 2018).

In assessing CSS performance in seed quality control, we also refer to an intermediary seed quality standard, namely Quality Declared Seed (QDS). QDS is defined as "seed produced by a registered seed producer which conforms to the minimum standards for the crop species concerned and which has been subject to the quality control measures outlined in the Guidelines" (FAO 2006, p.11), in which Guidelines refer to "Quality declared seed: Technical guidelines on standards and procedures" first developed by the Food and Agriculture Organization of the United Nations (FAO) in 1993. QDS has been recognized formally in many East African countries in recent years as a class of seeds that meet specific quality standards that are less stringent than those of certified seeds. QDS itself is not a seed system; it is a quality assurance system and regulatory adaptation that has been developed to support intermediary seed systems such as community-based seed systems. Importantly, QDS is not yet an official seed class in Nigeria. The National Agricultural Seeds Council (NASC) registers community-based organizations (CBOs) that meet specific criteria as accredited CSS. Through this system, buyers recognize that CSS-produced seeds meet some quality standards (though they do not meet all standards required for certified seeds or the exact sets of standards required for QDS). Nonetheless, we refer to QDS as a point of reference to which CSS in Nigeria can aspire, as QDS has proven to be workable in many East African countries, and targeting standards like QDS for CSS may also be a relevant policy objective for Nigeria.

Nigeria is an important case to study the viability of intermediary systems like CSS. Nigeria has the largest arable land in SSA, much of which is still out of reach of the formal sector's seed quality assurance system. Nigeria is constrained by one of the lowest number of seed inspectors and certification officers per arable land (Takeshima et al. 2022), which likely has to be supplemented by intermediary systems such as CSS in the short term.

This study contributes to various strands of literature. It expands the evidence base of CSS in Nigeria by adding insights on CSS for grains and some legumes like soybeans to previous studies that assessed the general characteristics, impacts, and challenges of CSS for cowpeas and groundnuts in Nigeria (Vabi et al. 2018; Iorlamen et al. 2021). Our study also builds on studies that describe general characteristics of CSS, such as seed cooperatives in West Africa (Access to Seed Index Foundation 2018), by providing detailed, focused descriptions of CSS opportunities and challenges within a particular geography in West Africa (northern Nigeria). Last, by providing evidence for CSS in Nigeria, our study expands the evidence base on CSS accumulated outside Nigeria, including but not limited to maize and rice in Nepal (Gautam et al. 2020; Vaiknoras and Larochelle 2023), sorghum in Mali (Rattunde et al. 2021), and grains and legumes in Ethiopia (Tebeka et al. 2017; Tesfaye 2023).

The remainder of the paper is structured as follows. Section 2 briefly describes CSS in Nigeria. Section 3 presents data and analytical approaches. Section 4 presents our results and discusses their implications for policy and regulation. Last, Section 5 provides discussions, while Section 6 concludes.

2 CSS in Nigeria

In Nigeria, community-based seed production has been recognized as critical to achieving its overall goal of increasing farmers' use of quality seeds. Nigeria's latest Seed Policy (Federal Ministry of Agriculture and Rural Development 2022) sees community-based seed production as vital in filling the gap where more formal systems like certified seed production are limited. It also recognizes the need for regulatory systems to improve the quality of seeds produced by CSS.

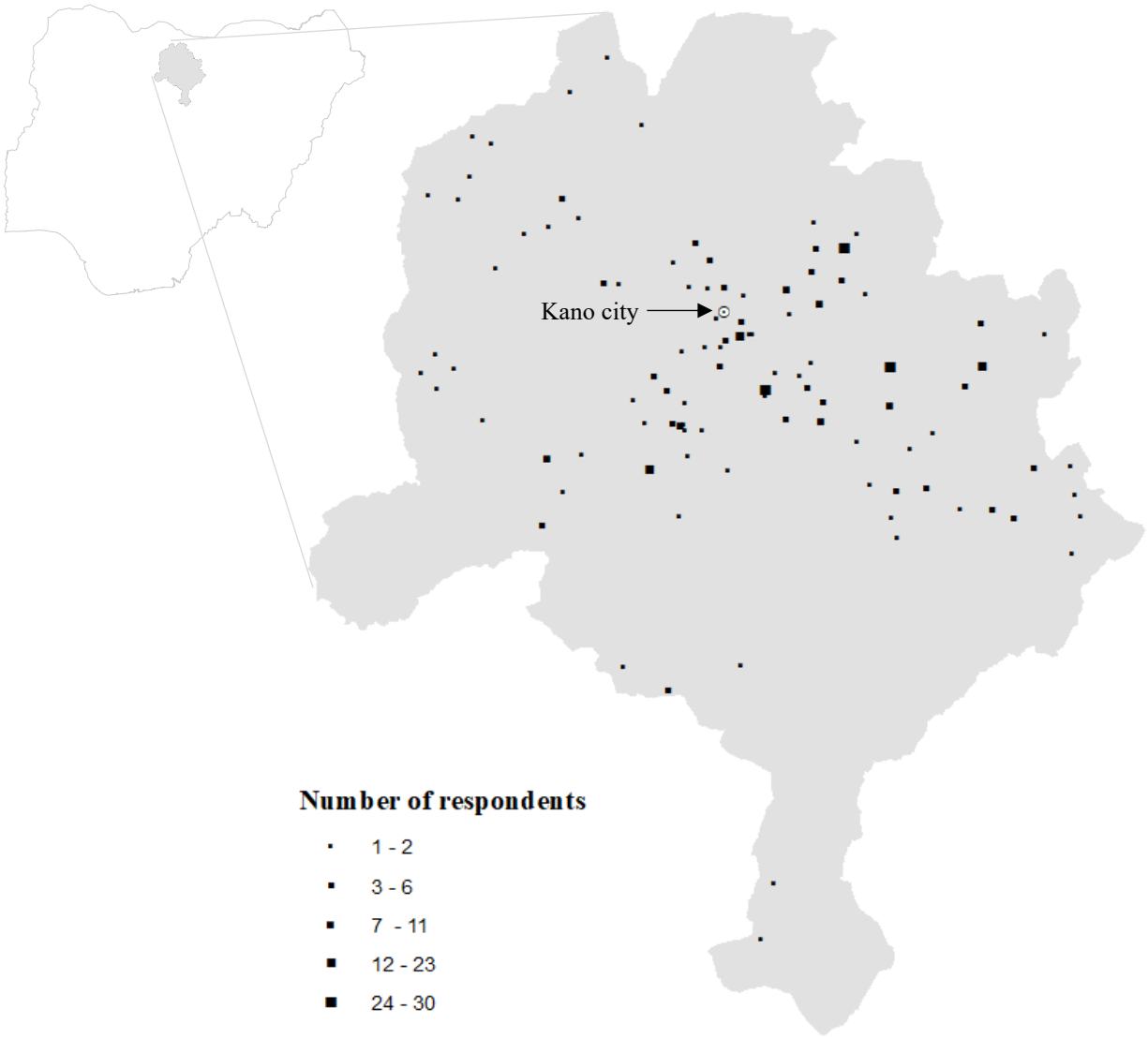
Information about CSS in Nigeria is generally scarce. Some CSS are relatively more formal, are fully registered as accredited seed producers by the government, and have engaged in the production of certified seeds for maize, rice, and other crops (NASC 2024). The NASC has also worked with donor agencies and registered new CSS as official seed producers every year.

However, a majority of CSS in Nigeria are still expected to engage in seed production informally without full NASC accreditation, although they are often formed on the basis of existing groups that are formally recognized, such as farmers' organizations, agricultural cooperatives, and self-help groups, among others. For example, in 2016, an NASC survey identified at least 560 farmer groups engaged in seed production across the country, but only two had been formally recognized (Access to Seed Index Foundation 2018). While official estimates are not available, in 2016 only 24 percent of farmers' seed requirements were supplied by the formal sector, suggesting that CSS, together with other intermediary and informal seed systems, likely have accounted for a significant share of seeds used in the country.

3 Data and methodology

We qualitatively assess the intermediary seed quality assurance system under the CSS, using a primary survey conducted in July 2023 of 380 seed producers who belong to CSS in Kano state in northern Nigeria. These respondents were purposively selected across several local government areas (LGAs), leveraging rosters of seed producers of maize, rice, cowpea, sorghum, and soybean from the list provided by the IITA together with the NASC, which has been promoting CSS concentrated in Kano state. One knowledgeable member of each CSS was interviewed using a semi-structured questionnaire about seed production practices in the 2022 rainy and dry seasons. While we asked these respondents about general information on their CSS, for seed production practices we focused on practices specific to the respondents, not the aggregate conditions at CSS levels. Respondents were nominated by the president/chairperson of each CSS. Therefore, respondent selection criteria were rather subjective but were likely to be based primarily on experiences such as being long-time members of respective CSS whose seed production activities were relatively well-known to the CSS presidents/chairpersons. More than 80 percent of respondents were selected among general members of CSS in this way, while about 20 percent of respondents were presidents/chairpersons themselves or were other officers holding administrative positions of respective CSS. Given such purposive sampling, results should not be interpreted as representative of CSS. Figure 1 illustrates the spatial distribution of the wards (an administrative unit below the LGA in Nigeria) of respondents.

Figure 1. Locations of survey respondents



Source: IFPRI (2023).

Using the survey data, we assess various dimensions of quality seed production through CSS, including general farm characteristics of respondents, along with seed production and marketing patterns. To gain richer insights into potentials and current challenges in CSS, we then assess economic aspects of seed production, as well as types of seed quality controls conducted and the extent of technical support received. Next, we run simple supplementary regressions to gain further insights into the associations between the use of improved management practices and seed production practices and the receipt of technical assistance like training and the use of improved management practices.

We qualitatively assess respondents' seed production practices relative to how successful CSS are. We describe respondents' characteristics and performance in aspects that successful CSS are likely to achieve. For example, successful CSS should be economically viable, generating positive net incomes that are a relatively significant addition to their overall incomes. Suc-

cessful CSS would also be applying a range of improved practices in their seed production activities. Ideally, they should be using foundation seeds or quality seeds from reliable sources, such as government and NGO programs, extension agents, agro-input dealers and traders, breeders, or seed companies, many of which are relatively more concentrated in states like Kano in Nigeria. New seeds would be acquired frequently instead of recycling them for multiple years—for example, every year for hybrid maize and soybean, and at least every two years for open pollinated varieties (OPVs) of maize, as well as for cowpea, rice, and sorghum. They should also know the names of the varieties of the seeds they acquire for multiplication. In addition, successful CSS should also be applying a range of quality control measures during seed multiplication, including inspecting seeds visually for purity or presence of pests, checking germination rates (which should be sufficiently high), conducting in-field measures like isolating seed fields from other crops, inspecting for weeds and off-type plants and disease in the seed lots, and using suitable packaging and bagging to protect seeds from damages. We discuss our descriptive results, particularly in Sections 4.2 and 4.3, comparing them with these ideal characteristics so that our interpretations are more contextualized.

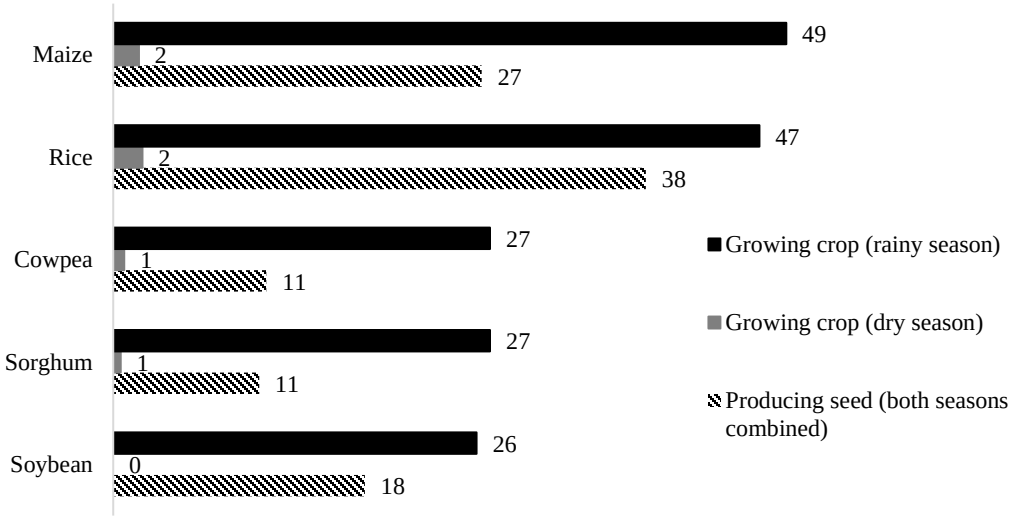
4 Results

4.1 Characteristics of sampled CSS and seed producers

The 380 CSS that we studied consist mostly of farmers' groups or agricultural cooperatives, whose main activities are farming and livestock raising as well as seed production. These CSS facilitate mutual learning on farming and seed production among members, mobilize community work, and sometimes provide education and loans and savings support. On average, these CSS consist of 35 members (4 women and 31 men), have been active for 14 years, and have been engaging in seed production for 8 years.

All respondents, as well as 21 percent of respondents, engaged in farming in the 2022 rainy season and the 2022 dry season production, respectively. Ninety-seven percent and 4 percent of respondents engaged in seed production in the rainy season and the dry season, respectively. Ninety-two percent and 28 percent of seed producers have seed storage facilities and seed conditioning facilities, respectively. Most respondents are smallholders, cultivating 1 to 2 hectares on average for both grain and seed production, dedicating a majority of land for seed production. In the rainy season, about half of respondents produced maize and rice, and about 30 percent produced cowpea, sorghum, and soybean (Figure 2). Overall, 27, 38, 11, 11, and 18 percent of respondents produced seeds of maize, rice, cowpea, sorghum, and soybean, respectively, during the two seasons combined.

Figure 2. Shares (%) of respondents producing each crop, by season, and producing seeds of each crop, both seasons combined



Source: Authors' analysis based on IFPRI (2023).
Note: The shares across crops are more than 100 percent because the respondent planted multiple crops.

CSS seed production activities started due to both demand and supply-side reasons. Thirty-seven percent and 21% of respondents reported that the unavailability of quality seeds in the community or the potential profitability of the seed production business, respectively, were the most important demand-side triggers. On the other hand, 41 percent of respondents reported that training provided by the government or NGOs on quality seed production was the most important reason their CSS started seed production.

Table 1 summarizes respondents' production and sales of seeds of each crop. Typically, respondents produce 0.3 to 0.8 tons of seeds annually depending on the crops and sell most of them. On average, seeds are sold at about 700 naira per kilogram (kg) for maize, 730 for rice, 690 for cowpea, and 600 for sorghum and soybean (US$1 = 800 naira in 2023). Seeds are typically sold to 30 buyers for maize and around 20 buyers for other crops.

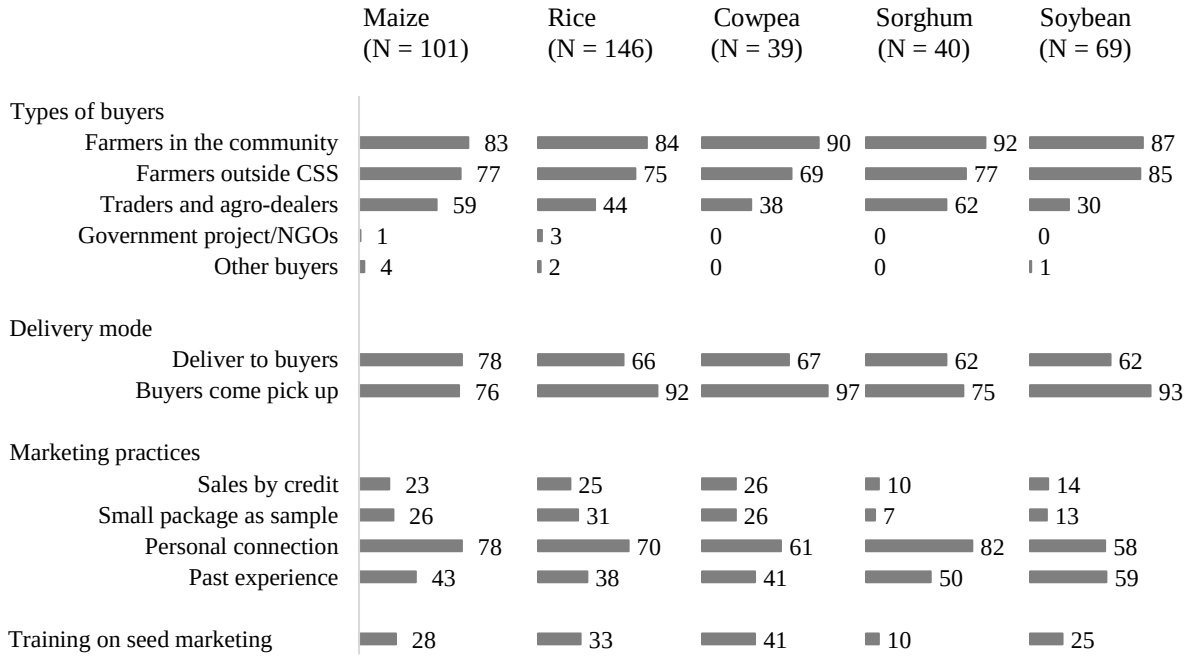
Table 1. Seed production and sales by individual seed producers, 2022 rainy season and dry season combined

Category	Statistic	Maize (N = 101)	Rice (N = 146)	Cowpea (N = 39)	Sorghum (N = 40)	Soybean (N = 69)
Quantity of seed produced (rainy and dry seasons combined, kg), excluding nonproducers	Mean	983	876	455	804	450
	Median	812	615	315	756	415
Number of group members involved in seed production per season per CSS	Mean	21	20	14	28	14
Quantity of seed sold (rainy and dry seasons combined, kg)	Mean	927	802	392	702	402
	Median	780	524	300	660	300
Average number of buyers per season	Mean	30	23	19	21	18
Average price of seed (naira per kg)	Mean	700	728	691	611	603

Source: Authors' analysis based on IFPRI (2023).
Note: CSS = community seed schemes; kg = kilogram.

Figure 3 presents the main types of seed buyers, common delivery mode, and marketing practices for produced seeds by sampled seed producers. For example, under the "maize" header, the figure indicates that 83% of maize seed producers in the sample sold seeds to other farmers in the same community, 77 percent sold seeds to farmers in other communities, and 59 percent sold seeds to traders and agrodealers. These figures do not add up to 100 percent because many seed producers sell seeds to multiple types of buyers. Across all crops, most buyers are farmers in the same or other communities, and to a lesser extent traders and agrodealers. In most cases, buyers come to pick up the seeds, while many seed producers also deliver the seeds to buyers. Most seed producers market or advertise their seeds to buyers with whom they have personally established relations. Nonetheless, smaller percentages of respondents also sell seeds on credit and offer small sample packages to promote their seeds.

Figure 3. Share (%) of seed producers of each crop by type of buyers, engagement in certain marketing practices and delivery mode for seed sales, and receipt of training on seed marketing



Source: Authors' analysis based on IFPRI (2023).

4.2 Economic viability (profitability) of seed production under CSS

Table 2 summarizes the sample median figures of key financial and operational data related to the sale of different crop seeds, including maize, rice, cowpea, sorghum, and soybean. It provides information on the quantity of seeds sold, the price per kg, total revenue, and various purchased input costs, such as fertilizer, pesticides, and hired labor, and other costs, including those associated with major seed handling activities (seed quality inspection, seed conditioning, and seed packaging). Unlike for the production of certified seeds or some other intermediary seeds like QDS, which relies on external inspectors, CSS mostly relies on internal inspection conducted by individual producers, or occasionally by group members following internally established quality assurance protocols. Therefore, spending on seed inspection is mostly for producers' own inspection activities, such as transportation costs to the field and any tools used for inspection.

Table 2. Seed production budgets by crop (median, 1,000 naira)

Category	Maize (N = 101)	Rice (N = 146)	Cowpea (N = 39)	Sorghum (N = 40)	Soybean (N = 69)
Total revenues	471	378	158	281	188
Purchased inputs					
Fertilizer	100	64	32	46	35
Pesticides	16	15	9	10	9
Hired labor	5	80	18	60	22
Seed handling costs					
Seed inspection	5	5	5	5	5
Seed conditioning	5	8	4	1	4
Seed packaging	8	10	4	7	4
Other costs	30	20	9	23	12
Total purchased input cost	188	245	73	143	84
Income from seed production	199	124	89	57	85

Source: Authors' analysis based on IFPRI (2023).
Note: Figures in disaggregated categories do not necessarily add up to the aggregate categories ("Total purchased input cost" and "Income from seed production") because data in this table are median values in each category, which are more representative of the characteristics of typical seed producers in our sample.

Median respondents earn about 471,000 naira and 199,000 naira (approximately US$589 and US$249, respectively) of revenues and incomes, respectively, from maize seed sales in the rainy season. Incomes from rice seed production are slightly lower, and incomes from cowpea, sorghum, and soybean seed production are relatively smaller. Nonetheless, these incomes are not negligible and are likely to account for a meaningful share of agricultural household incomes in northern Nigeria, such as in Kano, where poverty rates are much higher than in central or southern Nigeria. For example, in 2022, an average Nigerian farm household earned approximately 1.2 million naira (about US$1,500) of agricultural income from agriculture, fishery, and forestry combined, estimated using the agricultural sector value added in 2022, which was about 48 trillion naira (FAO 2022), and the number of agricultural households in Nigeria, which was 40.2 million in 2022 (Government of Nigeria 2024). Incomes from maize seed production would account for about 17 percent of the household's average overall agricultural income (US$249/ US$1,500). In reality, however, the actual shares may be much higher, given that median agricultural incomes would be much lower than the aforementioned average figure, and even more so in more impoverished northern states like Kano.

The purchased input costs are generally equivalent to 40 to 65 percent of total revenues earned, depending on the crops. Seed handling costs (seed inspection, conditioning, and packaging) account for about 9 percent (US$18) of all purchased input costs (US$188) in maize seed production. The shares of seed handling costs generally range between 10 and 20 percent of all purchased input costs among studied crops. The shares of seed handling costs are high despite a relatively limited extent of seed quality assurance activities (as discussed in the subsection below), compared to fuller seed quality assurance achieved for other intermediary seed classes like QDS with a similar cost share in other SSA countries (e.g., Uganda (Mastenbroek, and Ntare 2016, 83–93). For example, in Mastenbroek and Ntare (2016), the seed-handling related cost (seed treatment, storage, packaging material and marketing, and inspection and certification) for rice and millet generally is around 20 percent of total seed production costs, although more extensive seed quality assurance is conducted to meet the QDS standard. Technical support to improve the cost efficiency of quality assurance activities thus seems critical for the studied CSS in Nigeria.

4.3 Seed quality assurance by CSS: Scopes and challenges

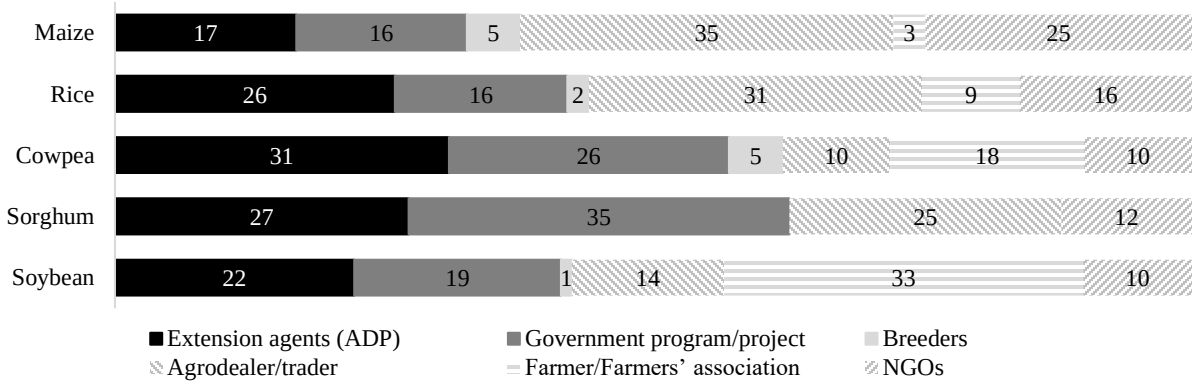
4.3.1 Selection of seeds and varieties to multiply

Figure 4 presents the source of seeds respondents multiply, as well as the frequency with which new seeds are acquired externally. Most CSS acquire "certified seed" or some other types of seeds from various sources due to the scarcity of foundation seeds, which would otherwise be an ideal source. On average, respondents acquire new seeds for multiplication every four to eight years depending on the crops (longer than the ideal frequency of one year for maize and soybean, and two years for cowpea, rice, and sorghum), while using recycled seeds for seed multiplication for all other years (not shown in Figure 4).

A majority of maize, rice, and soybean seed producers in the sample (63, 57, and 38 percent, respectively) acquire seeds from the private sector (agrodealers and traders, other farmers or farmers' association, NGOs, or directly from seed companies), while sourcing the rest from the public sector (extension agents with the Agricultural Development Project [ADP], government programs and projects, and breeders). For cowpea and sorghum, while slightly higher shares of seed producers acquire seeds from the public sector, about 40 percent still acquire seeds from the private sector.

These patterns suggest that significant shares of seed producers prefer to focus quality assurance efforts on seeds from the private sector. This could be because seeds from the private sector may be of more popular varieties in the market, may be more accessible, and may have higher seed performance—given the local agroecological conditions—than seeds from the public sector.

Figure 4. Distributions (%) of seed sources, and frequency of new seed acquisition[a,b]



Source: Author's analysis based on IFPRI (2023).
[a] Figures may not add up because of rounding errors.
[b] Most breeders in Nigeria, including maize breeders, are still in the public sector (Waithaka et al. 2018).

Typically, only about half of respondents could name the variety of the seed acquired and multiplied. These low proportions indicate weak knowledge and awareness of the different improved varieties and may also indicate that many respondents are using uncertified seed and/or older varieties.

For maize, SAMMAZ 14, 15, 16, and 27 (all OPVs) were the most common varieties used for seed multiplication, while some respondents reported using the newer varieties, including OPVs SAMMAZ 51, 52, and 55 and hybrid varieties SAMMAZ 62 and 63, which are com-

monly developed by IITA Ibadan and the Institute for Agricultural Research (IAR) Samaru. Importantly, newer varieties like SAMMAZ 62 and 63 have not yet been widely multiplied for certified seeds in Nigeria, and thus CSS may be playing supplementary roles in multiplying these seeds locally. For rice, FARO 44 was the most common variety used for seed multiplication. For cowpea, SAMPEA 14 was the most common variety used, while a few respondents mentioned FUMPEA 1 and SAMPEA 15. For soybean, 81 percent could name the variety (TG 448) or call the variety "Silver," which is TGX 1835-10E. In contrast, for sorghum, only 17 percent could name the variety, and SAMSORG 47 was the most commonly reported variety used for seed multiplication.

4.3.2 Quality assurance of seed multiplication

Survey respondents implement quality assurance measures in generally modest ways (Table 3). A majority (75 percent) conduct some visual inspection of seeds, including size and color. About 48 and 28 percent also inspect for the presence of pests and check seed purity and consistency, respectively. On average, 78 percent of seeds are found acceptable through these visual inspections. Thirty-two percent of respondents also inspect germination rates, finding them to be 73 percent on average, which is slightly below the 80 percent that respondents consider to be acceptable germination rates. Smaller fractions (not more than 15 percent) of respondents also employ additional in-field measures, such as isolating seed fields from other crops (on average, 24 meters) and checking for presence of weeds. Very few respondents check for off-type plants or regularly monitor the seed lot for disease and deterioration during storage. Only 1 percent receive inspection visits from the NASC.

About a third of respondents also place seeds in bags (which contain 95 kg of seeds on average), including 6 percent who place seeds in Purdue Improved Crop Storage (PICS) bags. A small fraction (12 percent) of respondents also place seeds in a designated storage space and apply preservative treatment. However, no respondents apply labeling or branding to their seed packages, suggesting limited premiums from such measures. Only 15 percent follow recommended practices for source seed acquisition, with particularly lower shares for maize (7 percent), sorghum (5 percent) and soybean (1 percent).

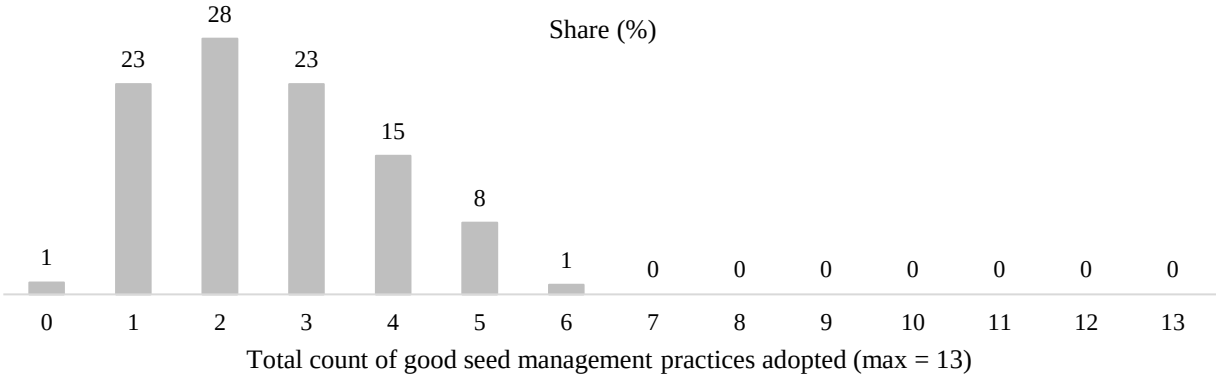
Table 3. Share (%) of respondents conducting various seed quality checks

Quality control measure	% of respondents	Note
1. Visually check seed appearance.	75	Sample average = 78 percent of acceptance rate based on visual checks (55–100 percent in range)
Evidence of pests	48	
Seed size	65	
Seed color	63	
Seed purity and consistency	28	
2. Check for germination rate.	32	Sample average = 73 percent of germination rates based on inspection (25–100 percent in range)
3. Isolate seed fields.	13	Sample average = 24 m from other crops (1–50 m in range)
4. Check for presence of weeds in seeds lot.	5	
5. Check for off-type plant.	1	
6. Regularly monitor and inspect seeds lot.	1	
7. Have inspection visits from the National Agricultural Seeds Council (NASC).	1	
8. Properly bag/package seeds.	37	Sample average of bag size = 96 kg
Purdue Improved Crop Storage (PICS) bags	5	
Ordinary bags	31	
9. Treat seeds with chemicals during storage.	2	
10. Add seed bag labeling/branding.	0	
11. Note variety name of the seed.	62	Based on whether respondents were able to name a variety name that corresponds to released varieties
12. Acquire seeds from reliable sources.	15	Based on whether seeds are acquired from reliable sources (government/NGO program; extension agents; agro-input dealers/traders, breeders, or seed companies) and acquired fresh (every year) for maize and soybean and every two years for rice, sorghum, and cowpea
Maize	7	
Rice	25	
Cowpea	29	
Sorghum	5	
Soybean	1	

Source: Authors' analysis based on IFPRI (2023).

Using the total count of good seed management practices in Table 3, we find that a vast majority (76 percent) of respondents adopt only up to 3 of 13 practices (Figure 5), which is much lower than the number recommended for a similar intermediary standard like QDS in other countries where it is recognized. For example, based on the FAO's recommendation, QDS in Uganda requires inspection of at least 30 percent of seed plots twice during the season, ensuring reasonable absence of weeds, keeping the off-type percentage to 20 percent or less, and achieving varietal purity of 98 percent (Waithaka et al. 2021). These practices were not adopted by a majority of respondents in our sample.

Figure 5. Share (%) of respondents by number of good seed management practices adopted



Source: Authors' analysis based on IFPRI (2023).

4.3.3 Seed management practices and seed production/sales

To see how good seed management practices benefit CSS seed producers, we assess simple associations between the number of good seed management practiced adopted and seed production and sales. We use farm size and seed multiplication history as controls (Table 4). Given the very small sample sizes for each crop, we simply estimate these associations through ordinary least squares regression. We also include results in which all variables are in natural log forms to check for robustness.

Table 4. Standardized associations between seed management practices and production/sales[a]

	Maize (N = 101)		Rice (N = 146)		Cowpea (N = 39)		Sorghum (N = 40)		Soybean (N = 69)	
Regressions/ variables		Natural log[b]		Natural log[b]		Natural log[b]		Natural log[b]		Natural log[b]
Dependent variable = quantity of seeds produced in the rainy season										
Good seed management practices[c]	0.105 (0.083)	0.081 (0.114)	0.040 (0.074)	−0.009 (0.084)	0.443*** (0.125)	0.470*** (0.134)	0.373*** (0.131)	0.396*** (0.144)	0.504*** (0.103)	0.383*** (0.111)
Land area for production (ha)	0.445*** (0.139)	0.226** (0.109)	0.333*** (0.105)	0.297*** (0.060)	0.389*** (0.124)	0.284** (0.135)	0.517*** (0.131)	0.380*** (0.144)	0.216** (0.104)	0.201* (0.112)
Number of years multiplied	0.195** (0.087)	0.187* (0.098)	0.156** (0.071)	0.133** (0.066)	0.172 (0.121)	0.177 (0.134)	0.015 (0.131)	−0.074 (0.145)	−0.096 (0.103)	−0.097 (0.111)
Intercept	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	.288	.125	.155	.109	.462	.333	.339	.208	.299	.167
Dependent variable = total value of seeds produced in the rainy season										
Good seed management practices[c]	0.140* (0.084)	0.147 (0.109)	0.016 (0.065)	−0.091 (0.079)	0.433*** (0.128)	0.593*** (0.104)	0.442*** (0.142)	0.463*** (0.140)	0.578*** (0.095)	0.472*** (0.104)
Land area for production (ha)	0.420*** (0.124)	0.242** (0.105)	0.343** (0.149)	0.332*** (0.067)	0.360*** (0.126)	0.364*** (0.105)	0.298** (0.143)	0.353*** (0.140)	0.240** (0.096)	0.250** (0.104)
Number of years multiplied	0.214*** (0.080)	0.203** (0.100)	0.352*** (0.105)	0.218*** (0.074)	0.208* (0.123)	0.240** (0.104)	0.027 (0.143)	−0.017 (0.141)	−0.014 (0.095)	−0.020 (0.104)
Intercept	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	.285	.163	.275	.164	.441	.595	.275	.252	.406	.275
Dependent variable = total value of seeds sold in the rainy season										
Good seed management practices[c]	0.125 (0.083)	0.035 (0.104)	0.012 (0.067)	−0.122 (0.077)	0.403*** (0.135)	0.525*** (0.120)	0.320** (0.146)	0.358** (0.150)	0.479*** (0.102)	0.350*** (0.112)
Land area for production (ha)	0.416*** (0.135)	0.279 (0.184)	0.326** (0.148)	0.334*** (0.070)	0.289** (0.134)	0.295** (0.121)	0.359** (0.146)	0.329** (0.149)	0.265** (0.103)	0.249** (0.112)
Number of years multiplied	0.199** (0.083)	0.032 (0.136)	0.337*** (0.104)	0.201*** (0.076)	0.260** (0.130)	0.274** (0.120)	0.088 (0.147)	−0.024 (0.150)	−0.011 (0.102)	−0.014 (0.112)
Intercept	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	.268	.125	.250	.161	.372	.464	.174	.149	.307	.164

Source: Authors' analysis based on IFPRI (2023).

Note: ha = hectares.

[a] Coefficients show one standard deviation change in each dependent variable with respect to one standard deviation change in each explanatory variable.

[b] All variables are transformed into natural logs.

[c] Extent of good seed management practices is the number of practices described in Table 3.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Results indicate that the associations between good seed management practices and seed production and sales are somewhat mixed, after controlling for cultivated area of each crop and the length of seed multiplication history. For sorghum and legumes like cowpea and soybean, the extent of good seed management practices adopted is often significantly positively associated with seed production and sales. Perhaps for cowpea, which has a low seed-to-grain multiplication ratio and is particularly susceptible to loss during storage (e.g., Takeshima et al., 2010), even the modest adoption of good seed management practices may have significant effects on production and sales. However, associations are generally insignificant for maize and rice. Longer seed multiplication history is significantly positively associated for maize, rice, and cowpea, potentially indicating the positive roles of experiences in seed multiplications. However, the associations are much weaker for sorghum and soybean. While the direction of causality is unclear, results are partly consistent with the hypothesis that there are significant returns to improved seed management practices. But they may not always be consistent, partly due to limited seed management techniques that cannot be fully enhanced through seed producers' experiences alone.

4.4 Potentials for technical capacity enhancement through training

The survey also reveals that exposures to external support for skill development vary across respondents and that expanded training efforts can be potentially effective in raising the technical efficiency of seed quality control (Table 5). About 60 percent of the seed producers interviewed indicated that they or someone in the group received some form of training or skills development on seed production. The typical training lasts 2.5 days and is provided to an average of 66 participants. Most training recipients regard the training as "extremely useful," and almost all regard it as "generally useful." Training frequency is generally limited, with almost 90 percent indicating that training is either rare or happens only sometimes (potentially regarding it as not frequent enough).

About 78 percent of the respondents agreed that they needed more technical assistance, training, and capacity building. Respondents regard as essential more training on seed preservation and storage, seed marketing, seed production in the dry season, use of and access to modern equipment for seed sorting and cleaning, and access to quality seeds. Also in high demand is additional training on techniques indirectly related to seed production—including pest control, pesticide types and usage, soil enrichment methods, and use of modern technologies—as well as information on available agricultural insurance products. Such interests in additional skill and capacity enhancement for seed production is also consistent with generally high aspirations among respondents; for example, 57 percent of the respondents plan to apply to become certified seed producers with the NASC in the future, pursuing seed quality assurance as their careers.

Table 5. Shares (%) of respondents receiving training and expressing demand for quality-seed production skills development

Category	Subcategory	Share (%)
At least one member in the group received any training, skills development in the past (%)		60
Usefulness of the training (among those receiving training)	Extremely useful	67
	Somewhat useful	33
Frequency of training (among those receiving training)	Often	12
	Sometimes	56
	Rarely	32
Need more technical assistance/training/capacity building		78
Plan to apply as a certified seed producer with the National Agricultural Seeds Council in the future		57

Source: Authors' analysis of 2023 field survey data.

Receiving training is positively associated with the greater likelihood that the seed producers implement some, though not all, of the seed quality control measures shown in Table 3. Table 6 presents the results based on propensity score matching methods. Our propensity score matching methods use the following explanatory variables to match the sample: natural log of the member size of CSS that respondents belong to; the share of women in these CSS; farm size and whether the respondent owns farmland; whether the respondent has seed storage facilities; whether the respondent has seed conditioning facilities; number of years respondents have been producing seeds; nighttime light intensity within the wards where respondents reside (which proxies the level of urbanization) (Elvidge et al. 2021); distance to the Kano state ADP as well as dummy variables indicating whether the respondent produce seeds for maize, rice, cowpea, sorghum, or soybeans.

Table 6 indicates that receiving training has been positively associated (with statistical significance) with a 9.0, 5.3, and 1.5 percentage point higher likelihood that the seed producers properly isolate seed fields, check for the presence of weeds in seed lots, and checking for off-type plants, respectively. These results are consistent with the hypotheses that training is effective in improving the quality of seeds produced by CSS. At the same time, associations with other quality control measures are not statistically significant, suggesting that the training received so far might not have been sufficient in raising seed producers' capacity and skills in those quality control measures. These results are also consistent with the findings in Table 5 that most seed producers still demand more training.

Table 6. Associations between training and seed producers' implementation of quality control measures

Category	Visual check	Germination rate	Isolation of seed fields	Weed check	Off-type check	Regular monitoring	Inspection visit	Seed bagging/ packing
Average effects	–0.015 (0.062)	–0.004 (0.066)	0.090** (0.045) [2.30]	0.053** (0.027) [2.40]	0.015* (0.009) [1.85]	–0.024 (0.016)	0.005 (0.005)	–0.060 (0.045)
Sample size	380	380	380	380	380	380	380	380
Treatment sample	227	227	227	227	227	227	227	227
On support	199	199	199	199	199	199	199	199
Control sample	153	153	153	153	153	153	153	153
R value	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
B value	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
H_0: Matched samples balanced	.918	.918	.918	.918	.918	.918	.918	.918

Source: Authors' estimation based on IFPRI (2023).
Note: Figures in parentheses and brackets are standard errors and Rosenbaum bounds, respectively. Rosenbaum bounds are generally close to 2 or above, indicating that results are fairly robust even when there are some unobserved confounders. R value and B value are less than 0,4 and between 0.5 and 2.0, suggesting suitable balancing properties of the matched samples (Rubin 2001).
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

5 Discussion

The existing CSS in Nigeria, including the CSS in Kano state that we studied, offer both potential and challenges. CSS in our study seem to complement the seed certification system in terms of varietal diversity for which seed quality assurance is provided. For example, some CSS are multiplying newer varieties, including newer maize varieties SAMMAZ 55, 62 and 63, which seem yet to be produced in significant quantity under the seed certification system (NASC 2024). While more certified seeds for these varieties may be produced in the future, for now CSS may be filling the gap where existing varieties of certified seeds may not work well. This is also consistent with the fact that in Nigeria, there are many pockets of areas where spillover potentials of certain varieties are high given their agroecological environment, even though these areas are distant from certified seed producers (e.g., Takeshima 2019). CSS can also serve as an institution to facilitate faster and wider diffusion and spread of fresh seeds where increased supply of seeds is urgently needed. As was seen, CSS mostly sell seeds to local buyers, in a similar way to other intermediary seed classes like QDS, and further complements seed certification, which focuses more on regional coverage.

However, existing CSS offer somewhat limited seed quality assurance in economically viable ways, and the extent of quality assurance achieved is insufficient compared to recommended QDS standards. More technical support can potentially facilitate higher quality assurance among CSS through technical assistance, and training and capacity development for improved and cost-efficient seed management techniques integrated as the central focus for all seed actors, including extension agents, CSS, other seed multipliers, agro-input dealers, traders, and grain farmers. Furthermore, despite the aforementioned use of varieties by some CSS not largely covered by the seed certification system, limited supply of foundation seeds or knowledge of actual varieties multiplied remains challenging for CSS, due to the overall shortage of foundation seeds produced and the limited knowledge of or access to the supply sources. A significant majority of farmers can only identify broader groups of varieties, such as SAMMAZ, FARO, SAMPEA, and FUMPEA, with limited knowledge of differences across individual varieties within

each group. There is some scope for expanding improved seed quality assurance by CSS by enhancing the awareness of varietal heterogeneity and stimulating the demand for optimal levels among CSS.

In addition, even though some quality control is relatively more effective within each CSS (internal quality control), rather than greater quality assurance targeted toward outside seed buyers, the actual quality assurance within CSS may still require significant external quality control. Such external quality control and quality assurance involve, for example, external monitoring by a relevant authority or the threat of external monitoring and consequences for regulatory noncompliance that can reduce rent-seeking behaviors (Gildemacher et al. 2017; Spielman et al. 2021) among seed producers within each CSS. Promoting demand-driven, endogenous growth of CSS, as well as clearly distinguishing CSS quality standards from other seed quality assurance systems, remains crucial. Doing so can mitigate crowding out and potential diluting other quality assurance systems, particularly Seed Certification, which some certified seed suppliers are involved with in Nigeria (Ragasa et al. 2024). Fortunately, as indicated earlier, most of our sampled CSS started seed production due to lack of access to quality seeds, including certified seeds, which likely minimized the risks that these CSS and Seed Certification would crowd out each other. Further investigations (described in more detail in Ragasa et al. 2024) also revealed that so far, clear distinctions are maintained, with certified seeds distributed in sealed bags with blue-colored tags, labels, or code, while CSS seeds are distributed in ordinary bags (only very few are in PICS bags), without any label or tag. Such distinctions should be maintained through continuous efforts in training and awareness campaigns.

6 Conclusions

CSS are a critical part of intermediary seed systems, which—together with other informal seed systems—provide a significant majority of seeds used by farmers in Nigeria and in many SSA countries. Their contributions are likely greater, given that some CSS are also part of the formal system in Nigeria. Nonetheless, most CSS in Nigeria are not recognized as formal seed producers, and their seed production practices as well as the quality of seeds they produce are understudied.

This paper narrows this gap by qualitative assessment of purposively selected CSS of key grains (maize, rice, and sorghum) and legumes (cowpea and soybean) in northern Nigeria. Our qualitative analyses indicate both the potentials and challenges of CSS to complement the seed certification system. Specifically, we discovered that many CSS have emerged endogenously, taking up seed production to address the challenges in access to quality seeds in their locality. Their seed production has often grown into viable businesses that have provided potentially significant additions to their incomes. Oftentimes, these CSS implemented some seed quality control measures, including conducting closer visual checks of seeds, checking germination rates, and bagging/packing seeds, among others. However, more extensive seed quality control may be significantly skill intensive, and many CSS still do not implement many of the recommended measures under some of the intermediary quality assurance standards like QDS. Our qualitative assessment suggests that future support for CSS can focus on technical support to raise the ability to engage in broader categories of quality assurance activities in economically viable ways and to improve the awareness and knowledge of different varieties and access to foundation seeds.

Our findings make significant contributions to the discussion about seed systems in general. Active seed production practices by intermediary seed systems, including those of CSS, observed in northern Nigeria re-emphasize that seed development approaches that only recognize dichotomous quality assurance systems (informal vs. formal) may severely constrain seed quality

improvement that is minor and intermediate but still meaningful for many smallholder farmers. Effective support for intermediary seed systems like CSS can also potentially contribute to the development of a more modernized rural seed market where the quality premium is significant and yet not readily reachable by more formal systems like seed certification. Last, the significant roles played by existing institutions such as farmer groups, agricultural cooperatives, and self-help groups to enable CSS suggest that group-based approaches can be instrumental in integrated seed systems development.

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