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The Role of Agricultural Projects in Building Sustainable and Resilient Maize Value Chain in Burkina Faso

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Abstract: Poor seed quality and climate change significantly affect the maize value chain in Burkina Faso. To address the challenges, a catalytic project titled "Strengthening resilient seed systems in the maize value chain in Burkina Faso—from research to markets" was initiated to enhance the development of a resilient maize value chain. This study aims to assess the role of the project in developing a sustainable and resilient maize value chain. In this study, we used a mixed approach in design and implementation: qualitative research using key informants' interviews, secondary data such as baseline survey reports, and lessons learned during the seed value chain greening intervention implemented in the Hauts-Bassins and Cascades regions of Burkina Faso. We analyzed qualitative data following the Gioia method. Kabako, a drought-tolerant hybrid seed variety, doubled crop yields in demonstration plots compared to smallholder farms and regional and national averages. Extension officers and village-based advisors (VBAs) were trained on improved seeds, composting, strip cropping, intercropping, crop rotation, and water management technologies and afterward trained smallholders. The VBAs trained smallholders on proper postharvest management practices and processing. The off-takers acted as the market. However, smallholders also sold their maize products in the informal open markets. The aggregator system was the missing link in Burkina Faso's maize value chain. There was limited involvement of women in the project. Results obtained from this study are valuable for policymakers and value chain actors in preparing policies and filling missing gaps for exploiting the potential of the maize value chain.

Keywords: value chain greening; village-based advisors; economic value; environmental value; social value

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1. Introduction

Maize (*Zea mays*) is ranked globally as the third-greatest grain crop after wheat and rice [1]. The crop is used for nutritional, pharmaceutical, livestock, and alcohol manufacturing [2,3]. In Burkina Faso, maize contributes to the food basket of approximately all households [4]. It is the most marketed cereal in Burkina Faso [5]. Maize is produced under 1,109,744 ha, with 1723.8 kg/ha productivity in 2021 [6]. Maize is a strategic crop for food security among the Burkinabe population [7]. It is mainly grown in Hauts Bassins, Boucle du Mouhoun, and Cascades regions. Although the long-term trend (1961 to 2021) shows that maize productivity has increased in Burkina Faso, in the last decade, the data show a declining trend (Figure 1a,b). Over the last decade, the decline in maize productivity can be attributed to climate change, soil fertility challenges, planting susceptible and vulnerable seed varieties, pests and diseases, and limited uptake of novel agricultural innovations [8–12]. Yields increased from 2017 through 2020, indicating that greening the maize value chain could have led to an increase in yields. However, the yield decline in 2021 could be attributed to low rainfalls and other weather patterns experienced during the year.

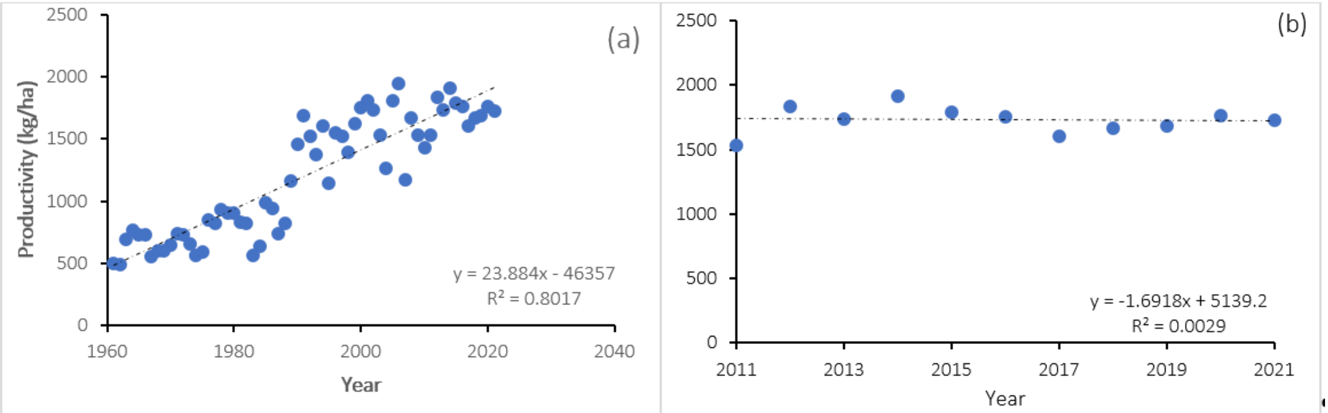

Figure 1. Maize productivity trends in Burkina Faso from 1961 to 2021 (**a**) and 2011 to 2021 (**b**) data source: [6].

Burkina Faso is severely faced with climate change, including droughts, floods, precipitation decline, heat waves, wind storms, and insect infestations that aggravate food insecurity [13]. The global hunger index (24.5) in Burkina Faso is severe [14]. The country has three climatic zones: the Sahelian, north-Sudanian, and south-Sudanian, which receive an annual average rainfall of 600 to 900 mm [15]. Long-term observations in Burkina Faso show that drylands are expanding, drought frequency is increasing, and flood events are increasing. The average temperature has risen by 0.26 per decade in the last three decades [16]. The decline in rainfall combined with an upward trend in temperature increases droughts, pests and diseases, and floods, thus lowering maize productivity [17–19].

Maize is mainly grown for subsistence in Burkina Faso and is among the major staple food crops, feeding almost 80% of the population [20]. However, maize production is severely affected by climate change and low-quality seed varieties [21]. Planting quality seeds enhances crop performance and yields [22]. Adopting climate-smart practices and hybrid varieties is critical to ensuring sustainability and resilience in the maize value chain [23,24]. Synergies among maize value chain actors such as the Burkinabe National Agricultural Research Institute, seed companies, input suppliers, financial institutions, extension officers, and off-takers, among others, are vital for enhancing resilience and sustainability. There has been significant investment in developing and promoting improved maize varieties, such as FBH 34 SR Bondofa, Barka, Red maize, and AGRA 7 (Kabako), to enhance the maize seed's resilience systems [25]. Despite the synergies in the maize seed systems, maize productivity has generally declined in the last decade [9].

The decline in maize productivity in Burkina Fasoi is attributable to several factors, including low soil fertility, climate change, pests and diseases, the low adoption of sustainable practices, the limited area under production, and limited access to extension and financial services [9,26–30]. According to Dao et al. [31], planting local seed varieties is a significant drawback to enhancing resilient maize systems. The local seed varieties are vulnerable to climate change, pests, and diseases [32]. In addition to the low adoption of improved seed varieties, the adoption of climate-smart agricultural practices is limited [33]. Adopting improved seed varieties and climate-smart agriculture is constrained by limited access to extension services, credit, and markets [34,35]. Therefore, enhancing maize value chain support services, such as access to credit, extension services, and contract farming, could improve the adoption of improved seed varieties and climate-smart agriculture.

The maize value chain's sustainability can be viewed from three economic, social, and environmental pillars [36,37]. Economic sustainability focuses on the long-term profitability of maize production. In contrast, social sustainability emphasizes how the maize value chain can support its actors' well-being, including farmers, seed companies, agro-dealers, wholesalers, and consumers. Environmental sustainability focuses on a maize value chain environmental impact. All three pillars are essential for a healthy and sustainable maize value chain. It is important to note that resilience refers to the ability of the maize value chain to bounce back or absorb shocks, thus ensuring continued production and supply [38]. The quality and safety of agricultural products is essential in the value chain [39–41]. A catalytic project, "Strengthening resilient seed systems in the maize value chain in Burkina Faso—from research to markets", was initiated to enhance the development of a resilient maize value chain funded by AGRA and UNDP [42]. The project was anchored on two key entry points for integrating sustainability principles into the maize value chain—building a responsive and resilient seed system and private sector integration in the value chain. The catalytic project focused on increasing production and adoption of climate-resilient, high-yielding maize varieties by farmers in two regions (Hauts-Bassins and Cascades). Specifically, the project aimed to increase the maize productivity of smallholder farmers by adopting improved technologies (seeds) and regenerative agricultural practices, such as using organic composts to complement inorganic fertilizers. With improved productivity, the project aims to contribute to the reduced expansion of farming lands into areas that can be conserved for biodiversity health and ecosystem resilience to the effects of climate change and land degradation, thus increasing smallholder farming households' and agricultural systems' capacity to better prepare for and adapt to shocks and stresses.

The project approach is essential in enhancing the sustainability of the crop value chain [43]. Agricultural projects support disseminating and adopting innovative approaches for enhanced sustainability and resilience. Value chain projects address sustainability at each stage, from input acquisition to consumption. However, despite the novelty of the agricultural projects in fostering sustainability, there is limited information on the contribution of "Strengthening resilient seed systems in the maize value chain in Burkina Faso—from research to markets" in Burkina Faso. Therefore, this study aims to assess the role of the "Strengthening resilient seed systems in the maize value chain in Burkina Faso—from research to markets" project in developing a resilient and sustainable maize value chain in Burkina Faso.

2. Methodology

2.1. Study Area Description

The maize value chain project and the study were implemented in Houet, Kénédougou, and Tuy districts in the Hauts Bassins region and Comoé and Léraba in the Cascades region, south west of Burkina Faso (Figure 2a), under the aegis of a UNDP- and Agra-led catalytic project entitled, "Strengthening resilient seed systems in the maize value chain in Burkina Faso—from research to markets". There are two climate types in the study area: tropic warm semiarid to the north and tropic warm sub-humid to the south (Figure 2b). The annual average rainfall ranges from about 900 mm from the north east to over 1100 mm to the south west of the study area (Figure 2c). The decadal rainfall trend in the last 50 years shows variable but generally depressed rainfall amounts ranging from −18 to −43 mm (Figure 2d). The average annual temperature ranges from 27 °C to 29 °C is variable, and the trend (1971 to 2020) is insignificant (Figure 2e,f).

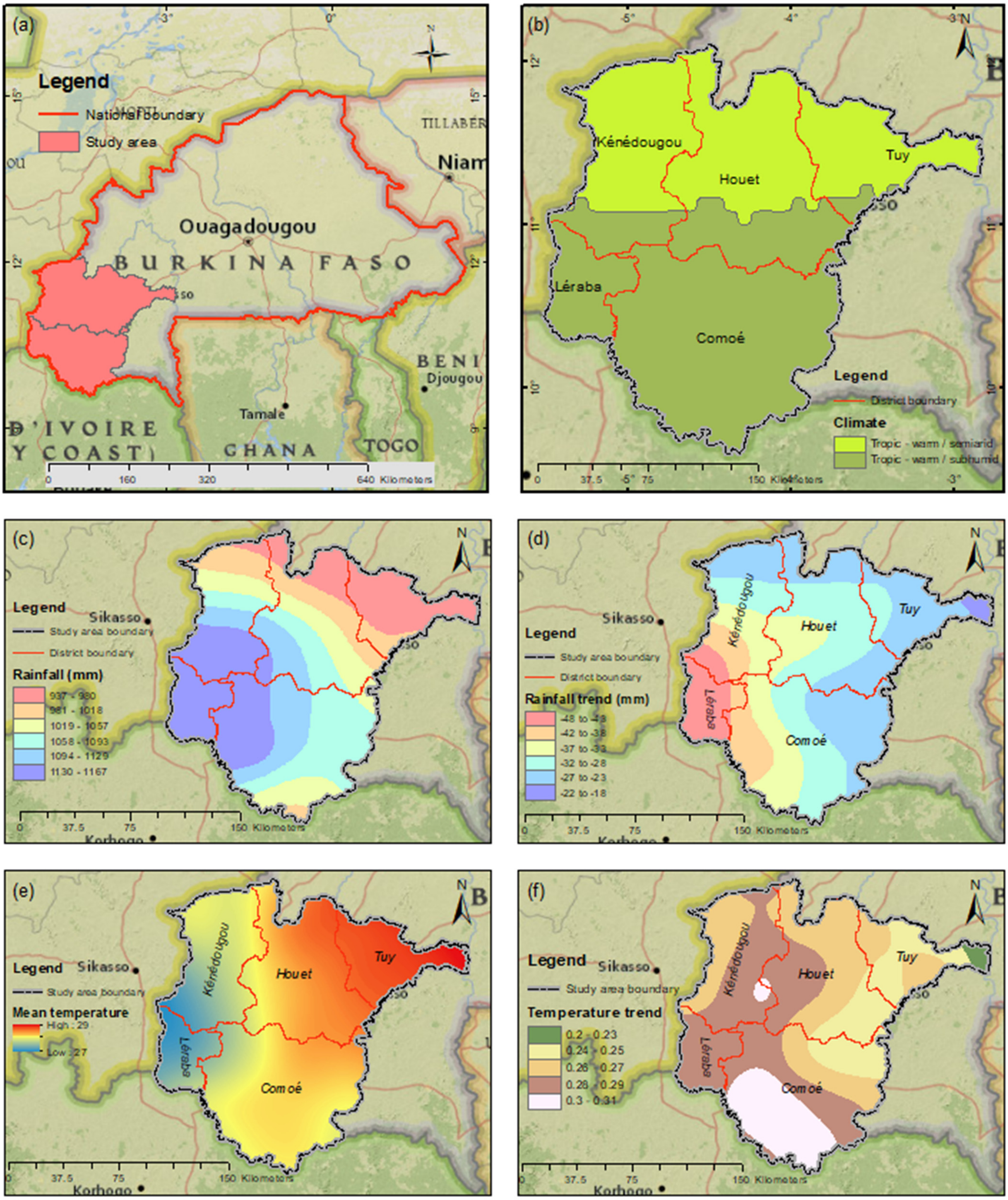

Figure 2. Study area maps showing various aspects: (**a**) the location of the study site in Burkina Faso, (**b**) the prevailing climate, (**c**) average annual rainfall, (**d**) rainfall trends-1971 to 2020, (**e**) average annual temperature, (**f**) temperature trends-1971 to 2020.

2.2. The Approach

The project design and implementation utilized a resilient and sustainable food value chain (RSFVCD) approach [44]. The project mainstreamed climate change impact resilience and long-term project sustainability. It identified the activities and actors involved in the maize value chain from inputs to consumption. There were five main stages: inputs, production, aggregation, processing, and distribution and marketing. The value chain's main activities were supplying inputs, producing, aggregating, value addition, transportation, marketing, and consumption. We identified various actors at each stage, including agro-dealers, seed companies, off-takers, fellow farmers, smallholder farmers, local traders, input suppliers, local traders, export markets, and food companies. NGOs, the government, extension officers, and financial institutions were the main actors providing support services (Table 1).

Table 1. Key stakeholders and roles.

Project Partners	Key Roles
National Agricultural Research Institutes	Development of Kobo variety
Government (Ministry of Agriculture)	Selection and formation of community agribusiness advisors (CAAs)
AGRA and UNDP	Provisions of extension services
SMR seed company	Seed multiplication and demonstration plots

RSFVCD requires a structurally balanced foundation: the three pillars that bring about (i) improved human well-being (economic impact), (ii) social equity (social impact), and significantly reduced environmental risks and ecological scarcities (environmental impact) [44]. In other words, for a farm enterprise to remain profitable in the long term, it should focus on the value chains' need to grow in community inclusivity and the efficient use of natural resources. Combining economic, environmental, and social goals enhances the quality of growth. Hence, resilient and sustainable food value chains combine sustainable, environmentally friendly practices with a resource-efficient food value chain approach for the social and economic well-being of the VC actors.

2.3. Data Collection

The study used both secondary and primary data collection methods. We collect data from project documents, including reports, conference papers, websites (https://resilientfoodsystems.co/ (accessed on 12 December 2022)), and peer-reviewed publications. Other secondary data included average annual rainfall (1971 to 2020), rainfall trends (1971 to 2020), and average annual temperature from the World Bank climate knowledge portal [45] and climate data from the RCMRD Geoportal [46].

We collected primary data using key informant interviews. The sampled key informants were extension agents, seed companies, and input suppliers. We collected qualitative data from five extension officers, two representatives of seed companies' employees, and ten input suppliers. First, we developed an unstructured interview schedule. The interview questions were loaded in an Open Data Kit (ODK) mobile APP. We interviewed the key informants and the workstations. First, the interviewee was requested to offer oral consent and was informed that the data would be used for the project purpose and that information would be reported anonymously. Following the introduction and oral consent, all the questions were asked, and the information was captured in the ODK application. In this study, we did not include human or animal samples.

2.4. Data Analysis

The key informants' responses were cleaned, coded, and checked for consistency. Once all the responses were cleaned and coded, common themes were identified. The themes were summarized and analyzed. The common themes included climate-smart inputs, climate change response in production, postharvest management practices, processing, and marketing. Additionally, the respondent's specific message was reported as a quote. The information was reported using the value chain approach aimed at greening the maize value chain.

3. Results and Discussion

This section presents the stages and actors in the resilient maize seed value chain in Burkina Faso. The results describe the greening activities in inputs, production, postharvest management, aggregation, processing, and marketing of maize. Additionally, the challenges at each stage are highlighted. Further, the role of service actors, such as financial institutions and extension agents, is emphasized. A scientific discussion of the findings across each stage is conducted to tie the results to scholarly evidence.

3.1. Inputs Supply

Greening of the maize value chain starts with sourcing climate-smart inputs. AGRA has invested in ensuring quality and timely access to inputs. AGRA helped the National Agricultural Research Institutes to produce a resilient and drought-tolerant maize variety, namely, AGRA 7, locally named Kabako. The variety is drought and pest/disease-tolerant and high-yielding. This ensures that maize production can withstand climate changes, such as erratic rainfall, drought, and pest and disease infestation. In addition to providing improved maize seeds, AGRA has trained farmers on using quality *pigeon pea* (*Cajanus cajan*) seeds. Further, smallholders are enabled to compost. Concerted efforts have been designed to ensure timely access to different fertilizers such as NPK and Urea.

The main challenge facing smallholder maize farmers in Burkina Faso is limited access to seeds and fertilizers. Poverty is a significant cause of smallholders' inability to purchase improved seeds and inorganic fertilizers. Additionally, there is limited access to chopping machines; hence, smallholders are forced to chop the crop residue for inclusion in the compost manually.

Access to improved and drought-tolerant maize seed varieties enhances crop yields [47]. Given that climate change (limited rainfall amount and uneven distribution) is a significant challenge in Burkina Faso [48], farmers' Kaboka variety multiplication and implementation was vital for greening the value chain. Additionally, compost utilization enhances carbon storage in the soil [49], thus limiting the carbon footprint of maize cropping systems. The inputs used in the maize value chain (improved seed varieties and compost) are climate-smart approaches. These ensured a nexus between the economy, society, and the environment.

3.2. Production

Greening maize production is essential for enhanced sustainability. Using environmentally friendly, socially acceptable, and economic practices enhances productivity and profitability while accounting for social and environmental justice. In Burkina Faso maize systems, various greening approaches were implemented in maize production: resilient maize seed varieties, stripping, intercropping, crop rotation, and external inputs such as compost and fertilizers.

AGRA produced and trained smallholder maize farmers on using resilient maize and pigeon pea seeds. The National Agricultural Research Institute breeders developed resilient seed products. It is noteworthy that the use of improved seed systems enables smallholder farmers to cope with climate change. For instance, planting early maturing seeds helps farmers earn income even under low and poorly distributed rains. Additionally, smallholders were trained on stripping, crop rotation, and intercropping the maize with pigeon peas.

> *"Under the AGRA-UNDP partnership, two hundred and twenty-four (224) demonstration plots on maize and Pigeon pea (Cajanus cajan) strip cropping were established in five provinces across the Hauts Bassins and Cascades regions in Burkina Faso by*

Village Based Advisors, trained by Burkinabe National Agricultural Research Institute (INERA).”

Based on the key informants’ interviews, seed companies played a key role in promoting good agronomic practices. The key informants’ interviews revealed that

“. . . SMR seed company participated in demonstration farms established, training farmers and transfer of water harvesting technologies.”

Strip cropping, intercropping, and crop rotation of maize and pigeon peas give smallholders multiple advantages. First, pigeon pea is a drought-resistant crop that can survive in vulnerable and harsh weather conditions. Therefore, smallholder farmers are assured of a legume harvest with limited rains. Additionally, the crop has high nutritional value and is, thus, suitable for addressing malnutrition and food insecurity. Additionally, the legume crop fixes nitrogen that is used by the maize. This improves soil fertility and enhances maize productivity. Notably, pigeon peas can survive during the dry season and provide forage when other crops are dry. This forage can be used to feed livestock or sold to earn income.

“The strip cropping consists of alternating six straight lines of maize with four lines of pigeon pea (Figure 3).”

Figure 3. Maize–pigeon pea strip cropping in Burkina Faso.

Continuous cropping without nutrient replenishment is a common challenge facing African smallholder maize cropping systems. Smallholder farmers in Burkina Faso were trained to prepare compost manure (Figure 4). Additionally, the project actively trained smallholder farmers on the 4Rs of fertilizer use, that is, the right time, the right place, the right type, and the right amount. The smallholders were trained to apply 5 Mt/ha of a compost microdose in planting holes, 300 kg/ha of NPK fertilizer on maize, and 50 kg/ha on the pigeon pea 15 days after planting. Totals of 100 and 50 kg/ha of urea are also applied to maize on the 30th and 45th day, respectively, after planting.

The fertilizers are buried in lines 10 cm from the maize and pigeon pea plants. During the second application of urea, pigeon pea leaves are cut and added to the urea before covering them with soil. This is to help the maize immediately benefit from the nitrogen captured in the pigeon pea leaves. The smallholders were equipped with a machine for chopping crop residues for compost manure preparation.

Smallholders were trained in planting and mulching. Rainfall timing is key for ensuring the optimal utilization of effective rains. The smallholders were trained on planting time and correct spacing. The crop residues are added to the soil as mulch. The crop residues help improve soil fertility (adding organic matter) and reduce evapotranspiration. Smallholders were also trained in integrated water management.

Figure 4. Compost manure preparation in Burkina Faso.

The local seed companies who participated in demonstrations in collaboration with INERA were tasked to produce Kabako-certified seeds (Table 2). The seeds were promoted to farmers and adopted in planting. The findings showed that maize yield per season was 4.5 Mg ha^{-1}, which is 2.2- and 2.57-fold higher than the regional and national averages of 2.05 Mg ha^{-1} and 1.75 Mg ha^{-1}, respectively. Therefore, using improved seeds and good agronomic practices doubled the maize yields.

Table 2. Maize grain yield (Mg ha^{-1}) in the study is for the 2021/2022 cropping season under smallholders' conditions and demonstration plots.

Region	District	Maize Grain Yield in kg ha^{-1}	
		Smallholder Farms	Demonstration Plots
Hauts Bassins	Houet	1298	3958
	Kénédougou	2039	5150
	Tuy	2049	4590
Cascades	Comoé	1996	4530
	Léraba	1748	4457

The production in demonstration plots was higher than in smallholder farms. In the smallholder farms, the production ranged from 1298 in the Houet district to 2049 kg ha^{-1} in the Tuy district. In the demonstration plots, the yields ranged from 3958 in the Houet district to 5150 kg ha^{-1} in the Kénédougou district. The study showed that the yield in demonstration plots was double that of smallholder farms. The demonstration plots' yields were twice as high as the regional and national averages. During the study, shelling and postharvest processing were in progress; hence, farm-based yield data were unavailable.

We found that greening maize production faces numerous challenges, including climate change, limited input access, and a shortage of chopping machines. Additionally, the intercropping was hampered by the limited access to pigeon pea seeds. The findings were consistent with the literature on the main challenges facing maize production in Burkina Faso: climate change and limited input access [9,29].

Climate-smart approaches demonstrated in the plots showed the potential to double crop yields compared to smallholder farms and regional and national averages. Therefore, doubling the yields has vast potential for promoting Burkina Faso to be food secure. The double yields could be attributed to increased soil fertility and climate change response using climate-smart technologies [50,51]. Our findings are similar to a report by the Oakland Institute and Alliance for Food Sovereignty in Africa [52] that established that compost increased maize yields by 45%. Compost and mulch (crop residues) also enhance moisture retention, thus increasing yields [53,54]. However, the main challenge of mulch is the livestock–crop conflict, where the residues are used as animal feeds [55].

3.3. Postharvest Management

Good postharvest management is key to enhancing quality grain yields maize [56]. Our study highlighted that the project trained smallholders on using proper storage facilities. Upon harvest, smallholders were trained on proper storage at appropriate moisture. Village-based advisors were key in preparing the smallholders on proper drying and improved storage facilities. The use of hematic bags such as agroZ was trained. The agroZ is biodegradable and airtight; thus, there is no application of external inputs/insecticides. Adopting postharvest management technologies in Burkina Faso reduces postharvest losses, improves the quality of grains, and increases smallholder farmers' returns and welfare [57]. Similar to our study, FAO [58] found that poor and long storage could deteriorate maize quality. However, storage in Burkina Faso is weak, leading to tremendous losses in maize [4].

3.4. Processing

The project played a crucial role in promoting the processing of maize in Burkina Faso. Quality processing is vital for enhancing marketable value. First, smallholders were trained in manually sorting and grading maize. The practice of manual sorting and grading improves the quality of maize by separating damage from clean grain. This enhances returns and reduces damage by pests and diseases. Further, sorting and grading lower aflatoxin infestation. However, poor processing could lead to 20% maize loss [58]. The maize processing activities in Burkina Faso are highly diversified and an essential link in the value chain [4]. There is a high demand for maize in Burkina Faso as a source of energy, vitamins, and minerals [59]. Therefore, processing quality maize is essential for quality life and returns.

3.5. Marketing

Off-takers link the farmers to the market. The projects had established maize off-takers who play a critical role by acting as the market. Despite serving as a maize market, the off-takers supply the farmers with inputs.

Ouedraogo Ousmane, an extension officer, explained the role of extension agents in market linkage.

> *"…the project is key in linking smallholders to agro-dealers (off-takers) and the open market. The smallholders are guaranteed market availability."*

The smallholders reported that maize farming played a significant role in income generation. Cost-benefit analysis shows an average gross margin (profit) of FCFA 767,500, approximating USD 1280 per hectare without accounting for pigeon pea grain and forage. The pigeon pea grain and forage income increase the economic gains and resilience of the maize cropping systems in Burkina Faso.

The maize value chain in Burkina Faso consists of inputs, production, aggregation, processing, distribution, and marketing [60]. In this study, we modified the global maize value chain by highlighting the available and missing links in Burkina Faso. The leading players in the Burkinabe maize value chains are seed companies and farmers. Agro-input suppliers play a crucial role as input supplies and in the market. However, the project did not highlight the role of agro-input dealers in extension and knowledge transfer. Seed manufacturing companies played a vital role in the establishment of demonstration plots. The Burkinabe maize value chain had a unique extension model using VBAs. However, the role of aggregators/off-takers in all the project activities was missing (Figure 5). The project also missed the maize markets for export, processing firms (industries), NGOs, and the institution.

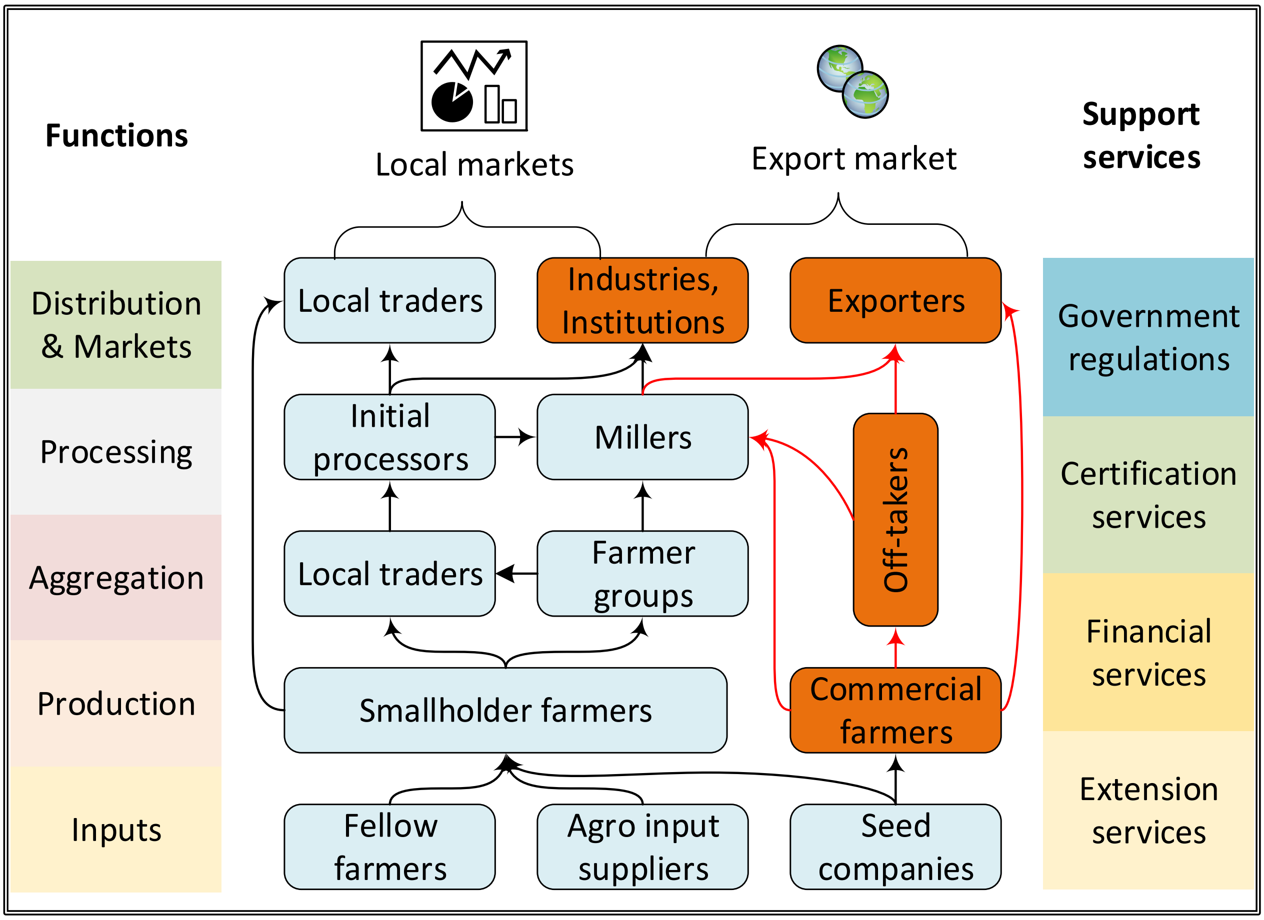

Figure 5. A map of maize value chain in Burkina Faso. Red lines are the missing links, and black lines are the available links.

Maize has immense economic value because its seeds are a source of starch. Starch is used in pharmaceutical industries as diluents, and the seeds are essential in alcohol manufacturing industries [3]. The maize market in Burkina Fosa is mainly informal [61]. However, there are various market actors in the local traders, off-takers, exports, processing, institutions, food services industries, wholesalers, livestock owners, retailers, food companies, retailers, and farmers (Figure 5). However, the catalytic project was missing different market actors, such as exporters, food companies, and processing firms. Therefore, prudent efforts to promote farmer–market linkages across different potential buyers are accentuated for the green maize value chain.

3.6. Support Services

The AGRA and UNDP organized smallholder field visits to train extension officers and village-based advisors (VBAs) for the catalytic project. Our study revealed that 128 extension officers and 237 VBAs were trained. Out of the 237 VBAs trained, 237 (236) maize and pigeon pea demonstration plots were established in Burkina Faso by Village Based Advisors (Table 3). Female involvement in the training and establishment of the demonstration plots was low. However, all ten females trained as VBAs implemented the demonstration plots.

Table 3. Extension officers and village-based advisors trained, and the demonstration plots established.

Régions	Districts	Extension Officers Trained		Village-Based Advisors Trained		VBA * Implemented Demonstration Plots	
		Men	Women	Men	Women	Men	Women
Cascades	Comoé	20	8	47	1	47	1
	Léraba	20	1	44	4	44	4
Hauts Bassins	Houet	18	9	48	1	47	1
	Kénédougou	22	5	44	2	44	2
	Tuy	20	5	44	2	44	2
Total		100	28	227	10	226	10

* Village advisors.

The demonstration plots were used to pass instrumental greening information to smallholder farmers. First, the smallholders were organized into groups (Table 4). Through the training, the demand for drought-resistant seeds increased (Table 4). Afterward, smallholders were trained on the uptake of the drought-resilient value chain and implementing sustainable technologies, including compost preparation. There were 10,099 smallholder farmers trained through the demonstration farmer (Table 4). Twenty-one (21) groups composed of three hundred and six (306) men and thirty-four (34) women were trained in composting (Table 5).

Table 4. Smallholders trained through demonstration plots and seeds demanded in Burkina Faso.

Regions	Districts	Smallholders Trained		Seed Demand (kgs)
		Men	Women	
Hauts bassins	Houet	1679	1035	730
	Kénédougou	1177	735	566
	Tuy	1260	496	336
Cascades	Comoé	1325	545	2100
	Léraba	1131	716	3036
	Total	6572	3527	6768

Table 5. Composting demonstration plots and smallholders from different villages in Burkina Faso.

Regions	Districts	Village	Groups	Men	Women
Hauts Bassins	Houet	Satiri	1	15	0
		Bobo	5	30	9
		Kouentou	1	5	0
	Tuy	Toussiana	1	14	1
		Houndé	2	34	0
		Koumbia	2	71	4
	Kénédougou	Djigouéra	1	6	4
		Orodara	2	21	4
		Koloko	1	45	0
Cascades	Comoé	Bérégadougou	1	13	4
		Moussodougou	1	12	3
		Niangoloko	1	15	0
		Soubakaniédougou	1	15	0
		Banfora	1	10	5
Total			21	306	34

The value chain needs support from the extension and financial institutions for practical greening [30,62]. Though extension services are vital in promoting the green maize value chain, the limited funding and lack of coordination in different regions limit its effectiveness in Burkina Faso [63]. Projects have established different extension approaches, such as community agribusiness advisors, village-based advisors, training agro-input extension officers, and leading farmers to enhance the dissemination of agricultural innovations [61,64]. AGRA and UNDP trained village-based advisors and extension officers in Burkina Faso to help enhance resilient maize seed systems. Through the VBAs, more than 10,000 smallholders were trained. This underscored the efficiency of the extension model in reaching farmers. Though credit systems play a significant role in enhancing the resilience of the maize value chain, we did not find substantial information on financial institutions' inclusion in the greening process.

4. Conclusions and Recommendations

The Burkina Faso catalytic project was central to greening the maize value chain. Kabako, a drought-resilient maize seed variety, was established for enhanced yields and coping with climate change. Evidence from the demonstration plots showed that the Kabako seed variety doubled crop yields compared to smallholder farms and regional and national averages. AGRA and UNDP used the village-based advisor (VBA) extension model. Extension officers and VBAs were trained on implementing improved seeds, composting, strip cropping, intercropping, crop rotation, and water management technologies. Intercropping maize and pigeon peas was a novel innovation that enhanced smallholders' livelihood by providing proteins and forage for livestock. Also, the pigeon pea fixed nitrogen in the soil, thus increasing maize yields. The leaves from the pigeon pea were also incorporated into the soil, acting as green manure. The aggregator system is a missing link in the Burkina Faso maize system. The VBAs trained smallholders on proper postharvest management practices and processing (sorting and grading). The off-takers acted as the market. However, smallholders also sold their maize products in the open markets. The study established limited involvement of women in the project.

Based on the study findings, we recommend gender mainstreaming in the project to include more women in the implementation. Including more women in the project could enhance gender sensitivity. The VBAs could act as project entrepreneurs by supplying improved seeds, fertilizers, and compost and selling maize yields to the off-takers. This could enhance market-led maize production. Smallholder groups need to be empowered to act as aggregators and bulk maize yields for marketing. We recommend the deliberate engagement of financial institutions and contract farming in the maize value chain for improved returns and resilience.

5. Limitation of the Study and Area of Further Research

We assessed the role of agricultural projects in enhancing the sustainability and resilience of the maize value chain in Burkina Faso using a qualitative approach. We underscored the role of agricultural projects in fostering the sustainability of the maize value chain. However, our study did not quantify the effects of the projects on productivity and profitability. Additionally, we did not assess the determinants of project participation and smallholders' adoption of sustainable practices. Further research is essential to evaluate the determinants of project participation and the effects of project participation on adopting sustainable practices and the profitability of the maize value chain.

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