

## Article

# Lives and Livelihoods in Smallholder Farming Systems of Senegal: Impacts, Adaptation, and Resilience to COVID-19

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**Abstract:** The COVID-19 pandemic has had immediate and cascading impacts on global agricultural systems. In Senegal, the immediate impacts include inaccessibility of inputs due to disruption in markets and supply chains, availability of labor, and changes in crop and livestock management practices. To understand the range of impacts on the biophysical and socioeconomic dimensions of smallholder farming systems, a survey was designed to identify the risk factors, assess the impacts, and explore appropriate mitigation strategies. The survey was administered to 917 smallholder farmers in 14 regions of Senegal in collaboration with a national farmer's organization and the Senegalese Institute of Agricultural Research (ISRA). The sample was comprised of farmers (men and women) and was stratified in each region to ensure representation from all agroecological zones of the country. The survey examined variables such as access to inputs, ability to plant, impacts on yields, markets, labor, the gendered division of labor, food security, and community well-being. The survey response indicated that 77.7% of respondents experienced a reduction in access to inputs, 70.3% experienced a reduction in ability to plant crops during the planting season, 57.1% experienced a reduction in ability to rent farm machinery, and 69.2% reported a reduction in yields. Similar findings were observed for labor, market conditions, and adaptation measures to reduce the impacts on farming systems and household livelihoods. This study advances the research on characterizing risk factors, assessing the impacts, and designing mitigation strategies for strengthening smallholder farming systems resilience to future shocks.

**Keywords:** food insecurity; livestock; labor; markets; gender equity; agricultural supply chain; mitigation



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## 1. Introduction

An understanding of the multi-faceted drivers of smallholder farming systems lies in contextualizing the assessment of the current status and trajectory of change. These drivers include demographics, markets and institutions, climate, and geopolitical issues [1]. Rural smallholder households adopt indigenous strategies to cope with short term changes as a self-regulatory mechanism [2]. African smallholder farming systems are impacted by abiotic and biotic stresses, and a cycle of poverty due to myriad factors. Attempts to improve the livelihoods of smallholder farmers in this region often fail due to a focus on maintaining equilibrium among all dimensions of farming systems [3]. In Senegal, agriculture is an important indicator of the rural economy and hence worthy of examining.

In March of 2020, Senegal witnessed the rapid transmission and spread of the global COVID-19 pandemic, which risked both the lives and livelihoods of smallholder farmers. The mobility restrictions and border closures had severe impacts on livelihoods, and the cascading impacts are yet to be assessed [4]. The inaccessibility of inputs and labor

impeded farm decisions and operations [5]. The impacts of COVID-19 on all components of agricultural systems make the outcomes unpredictable. Smallholder farming systems of Senegal embody systemic diversity in terms of the dynamic interplay among socioeconomic and biophysical drivers, which pose a challenge in assessing the impact of shocks such as COVID-19. Given that the pandemic is relatively recent, empirical research on the impacts of COVID-19 is still emerging, though some survey research has been published [6,7].

As the pandemic progressed, researchers across the globe started reporting the impacts on smallholder farming systems with a focus on food security and farming systems resilience [5]. The perceptions of smallholder farmers in Senegal were recorded through surveys highlighting the negative impacts on their livelihoods due to fractured supply chains and the disrupted market [6]. Moreover, extrapolating using a simulation model, Jha et al. [8] highlighted the impacts of reduced planting area and yield decreases on national gross domestic product (GDP). Government and development agencies developed several initiatives to mitigate the impacts of the pandemic with a special emphasis on food and nutritional security of households and strengthening the microeconomics of smallholder households [9–14]. Despite these initiatives, none of the researchers tried to assess impacts at each layer of smallholder farming systems and connect these with needed policies to support and strengthen the resiliency of smallholder farming systems to shocks such as COVID-19.

The main objectives of this study were to explore the actual experiences of smallholder farmers in Senegal, how those experiences impacted their systems, and how farmers developed short-term adaptive capacities. We hypothesized that livelihoods of smallholder farmers in Senegal were negatively impacted due to mobility restrictions and disrupted supply chains. The results from this survey help to quantify the impacts of COVID-19 on the livelihoods of smallholder farming systems and to understand mitigation strategies and measures to strengthen and build resilience of these systems to better manage and prepare for future events of this scale.

## 2. Data and Empirical Strategy

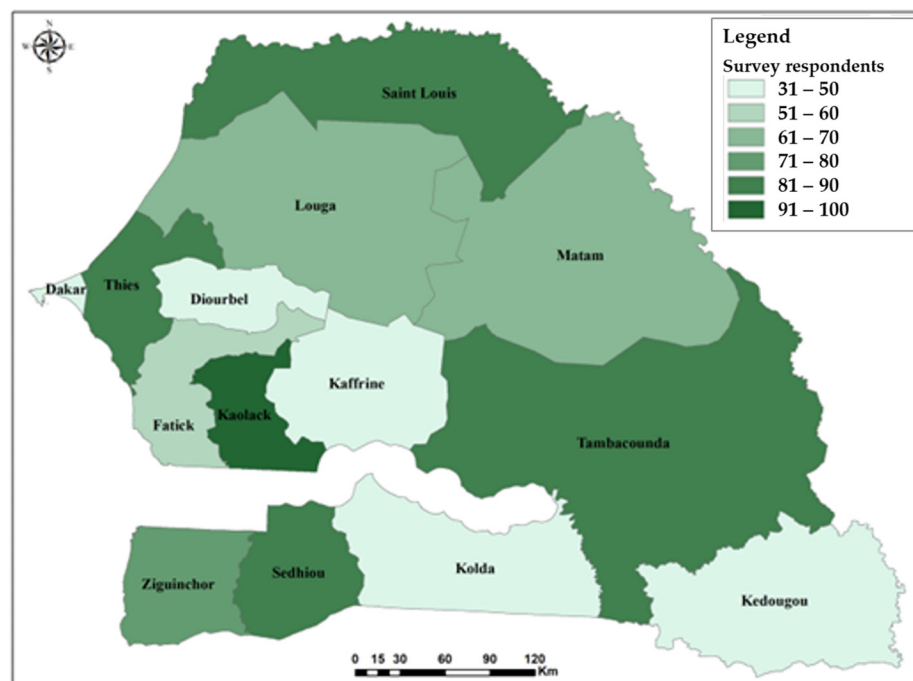
### 2.1. Study Area

Senegal is situated in West Africa surrounded by four coastal countries—Mauritania in the north, Guinea in the southeast, Guinea-Bissau in the southwest, and Mali in the east. Moreover, Senegal completely surrounds The Gambia, which stretches along the Gambia river. Senegal has a dry tropical climate with a total land area of approximately 192,530 km<sup>2</sup>, of which 16.6% (~3.2 million hectares) is arable land [15]. Administratively, the country has 14 regions (e.g., Dakar, Diourbel, Fatick, Kafrine, Kaolack, Kédougou, Kolda, Louga, Matam, Saint-Louis, Sédhiou, Tambacounda, Thiès, and Ziguinchor) which are further subdivided into 46 provinces (Figure 1). The total population of Senegal is 17.5 million (2022), which consists of 49% male and 51% female [16]. One quarter of the population is concentrated around the capital region of Dakar (Figure 1), which is 0.3% of total land area.

### 2.2. Economy and Agriculture

The agricultural sector, which includes crops, fishing, forestry, hunting and livestock, is 17% of the total GDP of USD 24.9 billion and accounts for 30% of the total employed population in the country as of 2020 [16]. The agriculture sector covers 46% of the total land area. The country is classified into three agroecological zones based on latitudinal descent of rainfall from the south to the north, i.e., southern humid, central sub humid, and northern arid and semi-arid agroecological zones [17]. The main crops cultivated in the southern humid region are rice (*Oryza sativa* L.), pearl millet (*Pennisetum glaucum* (L.) R. Br.), and maize (*Zea mays* L.). In the central sub humid region, the main crops are cotton (*Gossypium hirsutum* L.), pearl millet, sorghum (*Sorghum bicolor* L. Moench) and maize. In the northern arid region, the predominant farming system is agropastoral livestock production with groundnut (*Arachis hypogaea* L.) as the major crop. The pastoral farming system consists of small family farms that occupy 95% of the country's agricultural land under rainfed cultivation

in the northern arid and semiarid regions. Polyculture systems are followed in the irrigated peri-urban area of Dakar, which also supports commercial agriculture with horticulture and intensive livestock farming, with one percent of the working population and five percent of total agricultural land in the southern humid regions [18].



**Figure 1.** Administrative regions in Senegal and number of survey respondents in each region.

In 2017, the annual growth rate of GDP was 7.4% followed by steep declines to 6.2% in 2018, 4.4% in 2019, and 0.87% in 2020 [15]. The impacts of the pandemic significantly changed the economic outlook of Senegal, which relies significantly on food imports. Distorted supply chains due to fractured transportation, labor shortfalls, inflation, and price volatility, hit the informal sector the most [6]. As agriculture is the most dynamic engine of economic growth, there will be a fresh impetus to the gradual economic recovery if adaptation and mitigation strategies to reduce socioeconomic impacts are inclusive and sustainable [8].

### 2.3. Sample Population and Distribution

To assess the impacts of the pandemic on smallholder farming systems, a survey was designed and implemented following standard methods in the field [6,7,19]. The sample frame was drawn in collaboration with Réseau des Organisations Paysannes et Pastorales (RESOPP), a farmer organization that maintains a database of approximately 24,000 farmers, and the Senegalese Institute of Agricultural Research (ISRA). ISRA's research is primarily dedicated to developing and disseminating scientific agricultural research to smallholder farmers with the goal of achieving food security and reducing poverty. To be included in the survey, respondents needed to be smallholder farmers, head of household, and 18 years of age or older. The sample was stratified with farmers from each region to ensure representation from all agroecological zones of the country. The aim was to contact at least 65 farmers per region. This led to a total sample size of 917.

Local researchers from ISRA, who were well-versed with the farming systems, and the specific cultural context and language, administered the survey with the assistance of enumerators. Standard practices regarding consent and participation in the survey were followed. The survey design ensured that respondents were aware that their participation was voluntary and that they had the flexibility to withdraw from the survey at any time. It was also made clear that data would not be linked to individual respondents, thereby

protecting the respondents' identity. The local enumerators were trained in best practices prior to administering the survey. Based on the telephone survey, enumerators entered the responses into the Qualtrics© survey system.

#### 2.4. Survey Design and Timing

The survey was designed to capture the impacts of the pandemic on crop production practices and the livelihoods of farmers. Variables including access to inputs, ability to plant, impacts on yields, markets, labor, the gendered division of labor, food security, and community well-being were examined in the survey. The demographic questions helped in further analysis of the impacts on specific segments of the population. The survey design and the scale of responses are summarized in Table 1. Out of 917 individuals who were contacted to take the survey, 882 consented to participate and 35 opted not to take the survey; hence, a total response rate of 96%. The Qualtrics survey data and responses were analyzed using SPSS, a statistical software package.

**Table 1.** Summary of the survey design and questions.

Section Name	Question	Question Type(s)	Possible Responses
Consent	1.2	Willingness to participate	Will participate/will not
Farm Type	2.1	Crops, livestock, or vegetables	Yes/No
Agronomic and Biophysical Aspects of Cropping Systems	3.1–3.6	Main crops grown; production consumed at home; access to inputs; ability to plant, ability to rent machinery, yield reduction	Crop choices, % <sup>1</sup> ; agreement <sup>2</sup> scale
Market Issues	4.1–4.3	Access to the local/urban markets; issues related to transportation, distributors, harvest loss, sales	Percentage (%) <sup>1</sup> ; agreement <sup>2</sup> scale;
Labor Issues	5.1–5.6	Access to on-farm and off-farm labor; issues related to finances and availability of labor	Agreement <sup>2</sup> scale; availability scale <sup>3</sup> , (%) <sup>1</sup> and open-ended
Impacts for Women and Youth	6.1–6.4	Perceptions of what might occur for women and youth due to COVID-19	Agreement <sup>2</sup> scale and open-ended
Agricultural Adaptations and Mitigation	7.1–7.9	Mitigation plans: COVID-19 impact; contingency plans if any	Yes/no and why; open-ended for impact and contingency plans
Livelihoods and Social Well-Being	8.1–8.5	Access to food, markets, purchases, cost of food, and labor; access to social services, farm credit, subsidies, other financial support; challenges due do COVID-19	Agreement <sup>2</sup> scale; yes/no; and open-ended
Demographics	9.1–9.6	Relationship and activity with farmer organizations; age; gender; district; household size	Yes/no; amount of time; male, female, prefer not to say; age range; open-ended; household size
Agronomic and Biophysical Aspects of Livestock Systems	10.1–10.5	Main livestock raised; production consumed at home; access to inputs; Impact on raising, production reduction	Animal choices, % <sup>1</sup> ; agreement <sup>2</sup> scale

<sup>1</sup> Percent choices were 0–25%, 26–50%, 51–75%, 76–100%; <sup>2</sup> Used a 5-point scale (1 = Strongly Agree to 5 = Strongly Disagree); <sup>3</sup> Used a 5-point scale (1 = Much less to 5 = Much more).

The survey was launched on 1 March 2021 and closed on 31 May 2021. The first case of COVID-19 in Senegal was reported on 2 March 2020. The local government-imposed

mobility restrictions and border closures within two weeks of the onset. According to World Health Organization data, total COVID-19 cases in Senegal were 88,832 and the associated death count reached 1968 (as of 14 November 2022).

### 3. Results and Discussion

#### 3.1. Respondent Demographics

The socio-demographic characteristics of the respondents are highlighted in Table 2. The demographics revealed that the majority of the respondents were male (80.7%) with 19.2% female, and one respondent preferred not to respond to the gender question. The bulk of respondents were in the age range of 35 to 64 years (86.5%). In Senegal, the head of household is usually the eldest male, who manages common fields for family needs. Men generally grow cash crops and women take care of fruits and vegetables consumed at home or sold at domestic markets. For livestock, men take care of draft animals while women rear cattle and poultry. Adult members of the family work to maximize their income to support the household [20].

**Table 2.** Socio-demographic characteristics of respondents. Household size was on a 21-point scale, (1 = “1” to 21 = “More than 20”): Mean = 10.70, SD = 5.25.

Variable	Category/Description	Frequency ( <i>n</i> = 866) (%)
Sex	Female	166 (19.2)
	Male	699 (80.7)
Age	18–24	1 (0.1)
	25–34	54 (6.2)
	35–44	224 (25.9)
	45–54	307 (35.5)
	55–64	217 (25.1)
	65–74	54 (6.2)
	75–85 or older	9 (1.0)
Household Size	1–5	163 (18.7)
	6–10	288 (33.2)
	11–15	282 (32.6)
	16–20	61 (7.10)
	More than 20	72 (8.3)

Household size is a strong determinant of resilience capacity of the family and can be measured through assets, savings, and credit. Allocation of resources and active participation in agricultural activities are two prime factors which were impacted by COVID-19 in rural households [21]. Household size ranged from “1” to “more than 20” family members per household, with an average size of ten. Most African countries have average household sizes greater than five. Senegal has one of the largest household sizes in the world [22]. Nébié et al. [23] reported that large households in Senegal are most vulnerable to food insecurity and poverty especially in less educated rural families.

The following sections describe the respondents’ crop production, adaptations, mitigation activities, and issues related to markets, labor, women, and youth. The results also cover farmers’ livelihoods, social well-being and household and community challenges.

#### 3.2. Impact on Agriculture

Several reports have highlighted the impact of COVID-19-associated shocks on food production, supply chain disruptions, labor availability and food trade in Senegal [6,8,24–26]. In this study, we elaborate on the impacts on different components of agricultural systems based primarily on survey results. While there is a growing literature on building resilience in food systems [27–30], this survey brings insights into short-term and long-term resiliency of food systems to the specific case of COVID-19. Two-thirds (66%) of respondents grow primarily crops, whereas the remaining one-third (34%) practice diversified agricultural systems including livestock and horticulture. Van Hoyweghen et al. [26] have highlighted in their

studies that diversified cropping systems, focused on modern export-centric cultivation, have more resiliency in overcoming COVID-19 associated shocks than the smallholder domestic demand-oriented growers, which were hindered by local mobility restrictions.

The survey results also showed that 13.4% respondents consumed less than one quarter of their total crop production at home, and they sold their produce to domestic markets, whereas 21.7% respondents consumed more than three quarters of their total crop production at home. The mobility restrictions due to the pandemic might be an important factor as to why they could not sell their produce locally [26]. Farm size is a significant determinant in farm-related decisions such as land use distribution among household members, adoption of technologies, improving resource use efficiency, and other associated costs leading to estimating their vulnerability to abiotic and biotic shocks [31,32]. More than 40% of respondents to this survey have average farm sizes of two hectares or less (Figure 2). Small farm size prohibits the household from large scale commercial cultivation, however small farms, if diversified, provide an economic trade-off, and offer better resiliency in the context of biophysical attributes and ecosystem services. Contrary to that, Van Hoyweghen et al. [26] reported that smallholder farms that were domestic demand-oriented faced local mobility restrictions and were less resilient to COVID-19 associated shocks.

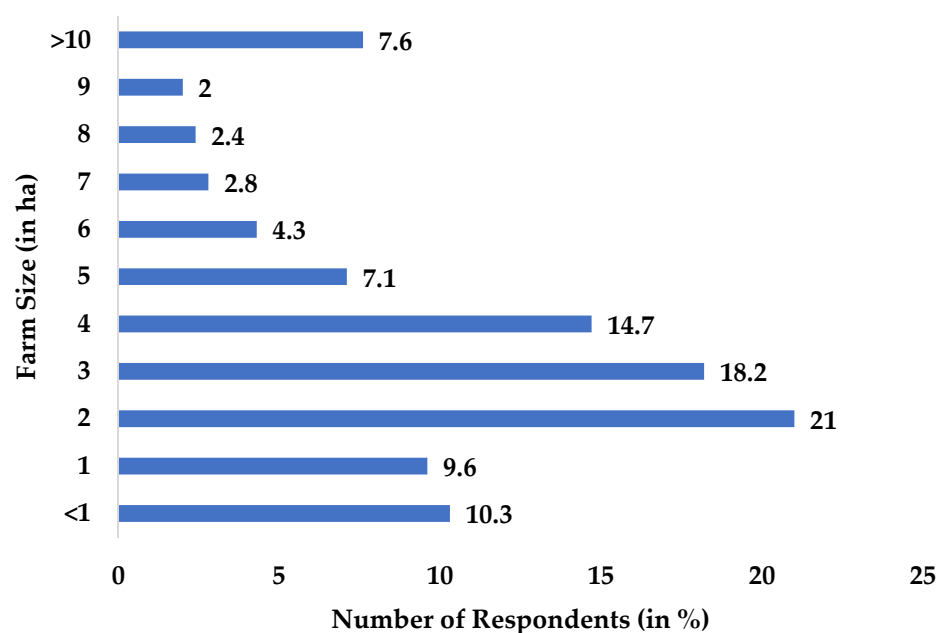


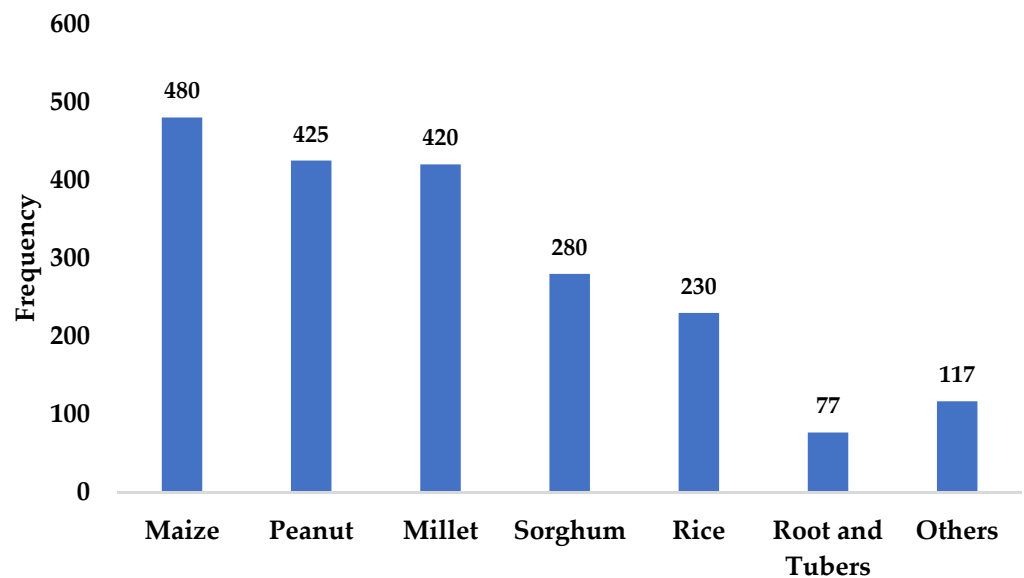
Figure 2. Farm size of survey respondents ( $n = 866$ ).

### 3.2.1. Impact on Cropping Systems

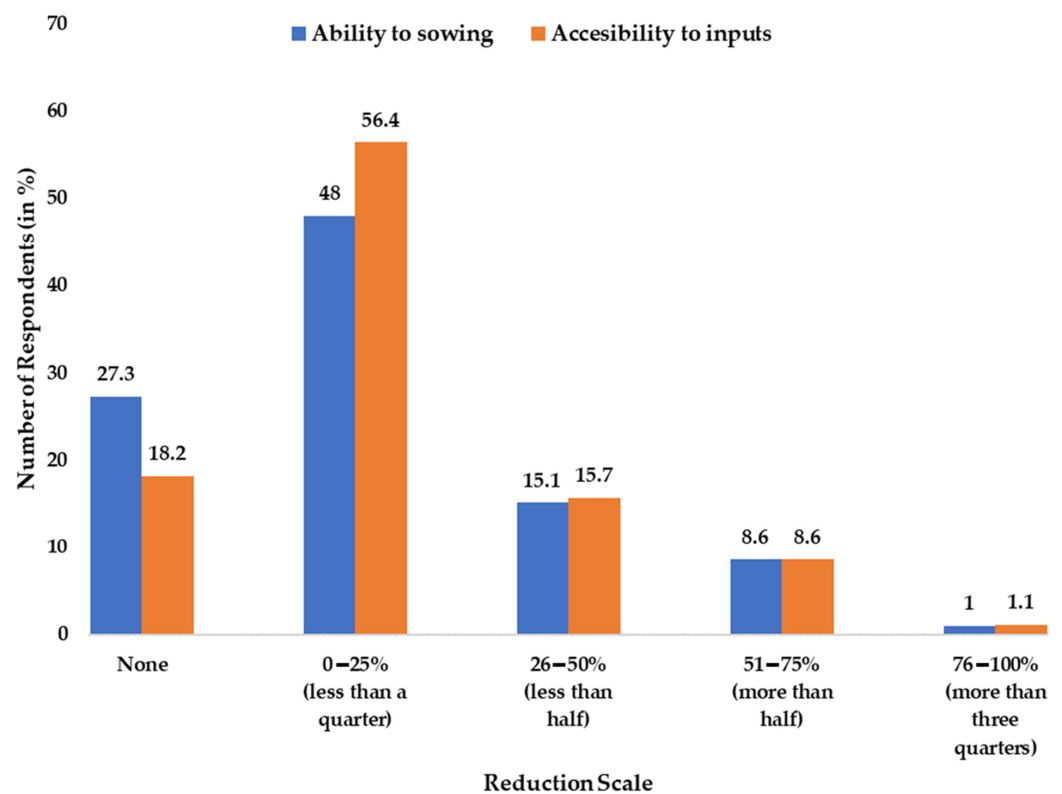
The survey results represent the national crop distribution in Senegal [18], with the predominant crops being maize (55%), peanuts (49%), millet (48%), sorghum (32%), rice (27%), and tuber crops (9%). About 14% of respondents also included other varieties of fruits and vegetables captured in the survey as “Others”, which are explained in the footnote (Figure 3). In addition to the ongoing agricultural research and development by several Senegalese agencies, the local government placed agroecological transition as one of the major initiatives in the Plan Sénégal Emergent (2019–2024), the key national policy framework that gives new impetus to expansion of cropping area with irrigation and other technological interventions [15]. The spread of the pandemic and associated restrictions hindered the pace of reform country-wide. Post-pandemic recovery will rely on the allocation of development funds to cropping intensification with a regular supply of inputs and technological interventions with the help of donors (e.g., Food and Agricultural Organization (FAO) (Rome, Italy), World Bank (Washington, DC, USA), United States



Department of Agriculture (USDA) (Washington, DC, USA), and United States Agency for International Development (USAID) (Washington, DC, USA)) and the local government.



**Figure 3.** Main crops grown among survey respondents ( $n = 866$ ). *Note:* Other responses described the following “other” crops: okra ( $n = 54$ ), onion ( $n = 49$ ), tomatoes ( $n = 48$ ), chili ( $n = 33$ ), eggplant ( $n = 29$ ), cabbage ( $n = 19$ ), hibiscus ( $n = 15$ ), watermelon ( $n = 15$ ), sorrel ( $n = 6$ ), fonio ( $n = 7$ ), cassava ( $n = 2$ ), banana ( $n = 2$ ), and wheat ( $n = 1$ ).



**Figure 4.** Reduction in ability to plant and accessibility to inputs among the respondents during the season ( $n = 802$ ).

The pandemic drastically affected the availability of inputs due to mobility restrictions leading to the inability to plant crops during the growing season. The survey results indicate that 48% of respondents faced up to a 25% reduction in the ability to plant. More

than 72% of the respondents reported some reduction in the ability to plant (Figure 4). The modeling extrapolation of the impact of reduction in planting area to the national level GDP of Senegal was explored by Jha et al. [8]. During the pandemic, Middendorf et al. [6] did a survey on the expected impact on the reduction in planting area and found that 50% of respondents anticipated reduction in their ability to plant by  $\leq 50\%$ . The post-pandemic survey results concur with the survey of anticipated impacts during the peak period of the pandemic. However, median anticipation during the pandemic moved from less than half to less than quarter in the post-pandemic actual survey.

**Table 3.** Thinking about your experience of what has occurred due to COVID-19, please indicate your agreement or disagreement with the following statements. COVID-19 has . . .

Statement	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Mean (SD)
Reduced my <i>access</i> to inputs (e.g., seeds, fertilizers, etc.) during this season.	77 (9.6%)	65 (8.1%)	38 (4.7%)	198 (24.7%)	424 (52.9%)	802	4.03 (1.32)
Reduced my ability to <i>plant</i> crops during this season.	82 (10.2%)	94 (11.7%)	63 (7.9%)	216 (26.9%)	347 (43.3%)	802	3.81 (1.36)
Reduced my ability to <i>rent</i> machinery during the planting season	95 (11.8%)	100 (12.5%)	151 (18.8%)	160 (20.0%)	296 (36.9%)	802	3.58 (1.39)
Reduced my crop <i>yields</i> in the harvest season.	76 (9.5%)	87 (10.8%)	85 (10.6%)	211 (26.3%)	343 (42.8%)	802	3.82 (1.33)

Note: Means are on a 5-point scale (1 = Strongly Disagree to 5 = Strongly Agree).

**Table 4.** How much of a reduction in crop yields per crop type (e.g., cereals, legumes, tubers) did you experience due to the impact of COVID-19 during this harvest season.

Crop Type	None at All	0–25% (Less than a Quarter)	26–50% (Less than Half)	51–75% (More than Half)	76–100% (More than Three Quarters)	Total	Mean (SD)
Cereals (Millet, rice, maize, sorghum)	369 (45.7%)	220 (27.2%)	158 (19.6%)	56 (6.9%)	5 (0.6%)	808	1.90 (0.99)
Legumes (Cowpeas, peanuts, beans)	161 (19.9%)	432 (53.5%)	151 (18.7%)	56 (6.9%)	8 (1.0%)	808	2.16 (0.85)
Root and Tubers (Potatoes, yams)	300 (37.1%)	287 (35.5%)	145 (17.9%)	68 (8.4%)	8 (1.0%)	808	2.01 (0.99)
Other types of crops not listed above	354 (43.8%)	210 (26.0%)	145 (17.9%)	73 (9.0%)	26 (3.2%)	808	2.02 (1.13)

Note: Respondents received this item if they indicated their farm was “primarily crops” or “diversified crops, vegetables, and livestock”. Means are on a 5-point scale (1 = None at all to 5 = 76–100%). The Other responses listed the following crop types (13 of the responses listed multiple crop types): ras ( $n = 20$ ), peanut ( $n = 15$ ), market gardening ( $n = 7$ ), jaxatu (eggplant) ( $n = 5$ ), chili pepper ( $n = 5$ ), tomato ( $n = 4$ ), mil ( $n = 3$ ), okra ( $n = 3$ ), onion ( $n = 3$ ), sweet eggplant ( $n = 3$ ), pepper ( $n = 2$ ), banana ( $n = 1$ ), bissap ( $n = 1$ ), cabbage ( $n = 1$ ), corn ( $n = 1$ ), cowpea ( $n = 1$ ), legumes ( $n = 1$ ), melon ( $n = 1$ ), pette recolte ( $n = 1$ ), and zucchini ( $n = 1$ ).

Respondents were also asked about their experiences regarding their ability to plant, access to inputs, ability to rent farm machinery, and yield change at the end of the growing season. The responses indicated that 77.6% of respondents experienced a reduction in access to inputs, 70.2% experienced a reduction in their ability to plant crops during the planting season, 56.9% experienced a reduction in ability to rent farm machinery during growing season, and 79.1% reported a reduction in yields. These percentages are the aggregation of the two response categories “somewhat agree” and “strongly agree” (Table 3). The COVID-19 pandemic had an impact on crop production through its disruptive effects on input production, supply, and availability, leading to inordinate distortions of planting choice and calendars. Shrinking manufacturing capacity of chemicals and their distorted supply due to mobility restrictions led to reductions in access for farmers. Hence due to restricted availability of inputs, farmers could not manage biotic stresses for many crops leading to reduction in yields [21,25,33,34]. Unlike epizootic pandemics (e.g., avian flu, swine flu), which have direct impacts on livestock and produce, COVID-19 has indirect impacts on food production systems.



Labor intensive food production systems require changes in management strategies such as staggered work shifts to avoid the physical concentration of workers with the goal of curtailing the transmission of virus and hence the cumulative impact on yield reduction. Surveys in African counties revealed that young adults are less likely to be infected with the COVID-19 virus and are a major part of labor force in rural agriculture. [35]. Despite that, the loss in crop yields might be attributed to changes in planting and harvesting calendars, and unavailability of inputs and farm machinery.

The survey results show that there was some level of reduction in major crop yields. For example, 54.2, 80.3, 60.7, and 56% of respondents experienced reduction in yield for cereals, legumes, root and tubers, and others category respectively as illustrated in Table 4.

### 3.2.2. Impact on Livestock Systems

Livestock is an essential asset to rural smallholder livelihoods globally. West African arid agroecosystems are suited to livestock-centric agriculture and hence their contribution to GDP is more than 25% [36]. Livestock breeding is widespread in northern and central Senegal, especially Ranerou and Medina Yoro Foulah, where the pastoral farming system is widespread, indicated by the high percentage of households (60.2%) rearing livestock [37]. The survey results suggest that goats/sheep and cattle are two widespread types of livestock reared by respondents (Figure 5). Some also rear donkeys and horses, primarily for transportation purposes [38].

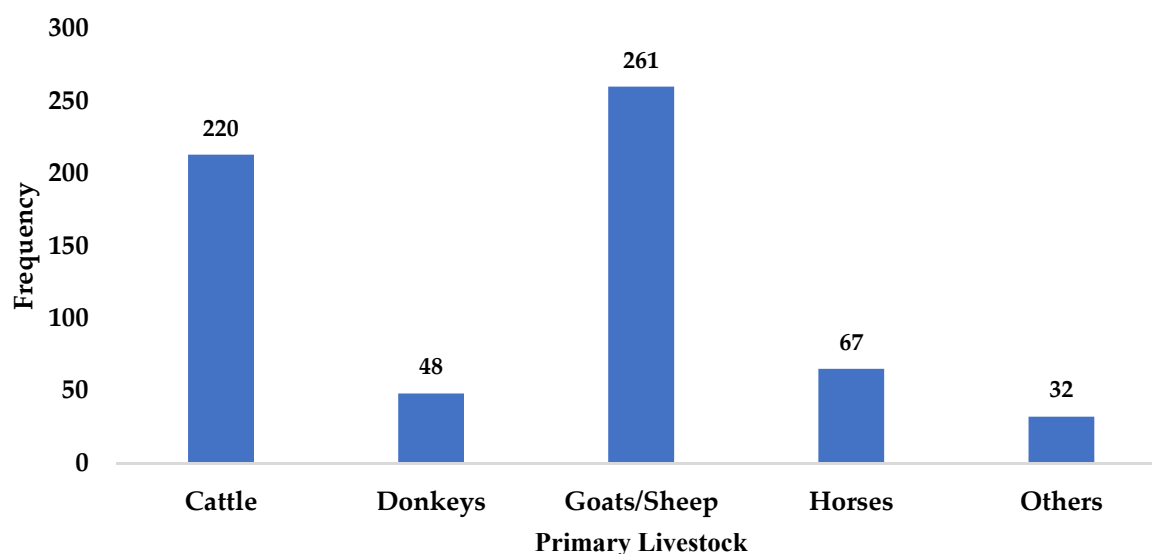


Figure 5. Primary livestock raised by respondents ( $n = 300$ ).

The survey indicated that 76.5% of respondents experienced a reduction in access to inputs for livestock due to households facing a lack of access to markets and other extension services; 71.9% experienced a reduction in their ability to feed livestock during the season due to the disrupted markets and supply chains; 77.1% experienced a reduction in their ability to sell livestock during the season, and 44% reported an inability to rent draft animals for farm operations during the season. These percentages are the aggregation of the two response categories “somewhat agree” and “strongly agree” (Table 5). Decreasing consumer demand for animal products due to changes in diet patterns during the pandemic raised undue concerns associated with COVID-19, and unawareness led to disruptions in the livestock supply chain [39]. Therefore, the cumulative impact of feed shortage, lack of access to veterinary care, and deteriorating demand for animal produce during lockdown, led to a reduction in livestock production in Senegal. The decline in livestock productivity had a cascading impact on the microeconomics of households.

**Table 5.** Thinking about your experience of what has occurred due to COVID-19, please indicate your agreement or disagreement with the following statements.

Statement	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Mean (SD)
Reduced my <i>access</i> to inputs for my livestock (e.g., water, labor, feed, etc.) during this season.	20 (6.7%)	20 (6.7%)	30 (10.1%)	99 (33.5%)	127 (43.0%)	296	3.99 (1.18)
Reduced my ability to <i>feed</i> my livestock during this season.	31 (10.5%)	21 (7.1%)	31 (10.5%)	90 (30.4%)	123 (41.5%)	296	3.85 (1.31)
Reduced my ability to <i>sell</i> my livestock during this season.	20 (6.7%)	17 (5.7%)	31 (10.5%)	98 (33.1%)	130 (44.0%)	296	4.01 (1.17)
Reduced my ability to <i>rent</i> draft animals for farm operations.	25 (8.4%)	22 (7.4%)	119 (40.2%)	66 (22.3%)	64 (21.7%)	296	3.41 (1.15)

Note: Means are on a 5-point scale (1 = Strongly Disagree to 5 = Strongly Agree).

To ensure the resiliency of livestock production systems to the current and future pandemics, the region-specific preparedness, and mechanisms for recovery from disruption need to be addressed. Since livestock is an important component of food security in developing countries such as Senegal, research that can strengthen the understanding of how this system can become more resilient to meet food security objectives needs to be addressed. The government of Senegal has formulated short-term and medium-term plans to strengthen the livestock industry through technical support in disease and feed management, and financial support for investment in this sector with the goal of exporting livestock by-products [40].

Among the 300 respondents with livestock, 72.2% had more than 10 animals per household, and 82% of respondents used less than a quarter of the livestock production for home consumption. Culturally, livestock also serve as a status symbol in rural Senegal. Ownership varies with gender, as men usually own the draft animals and women own milk animals for domestic consumption. Moreover, if men control milk animals, they sell some proportion in the domestic market [20]. However, due to mobility restrictions, local markets were shut down, and therefore caused difficulties in selling of livestock for other consumables. Farmers sell or exchange cows and other livestock for life events such as weddings or other rituals [21,36]. In addition to their economic value, livestock also ensures the nutritional security of smallholder farmers [41].

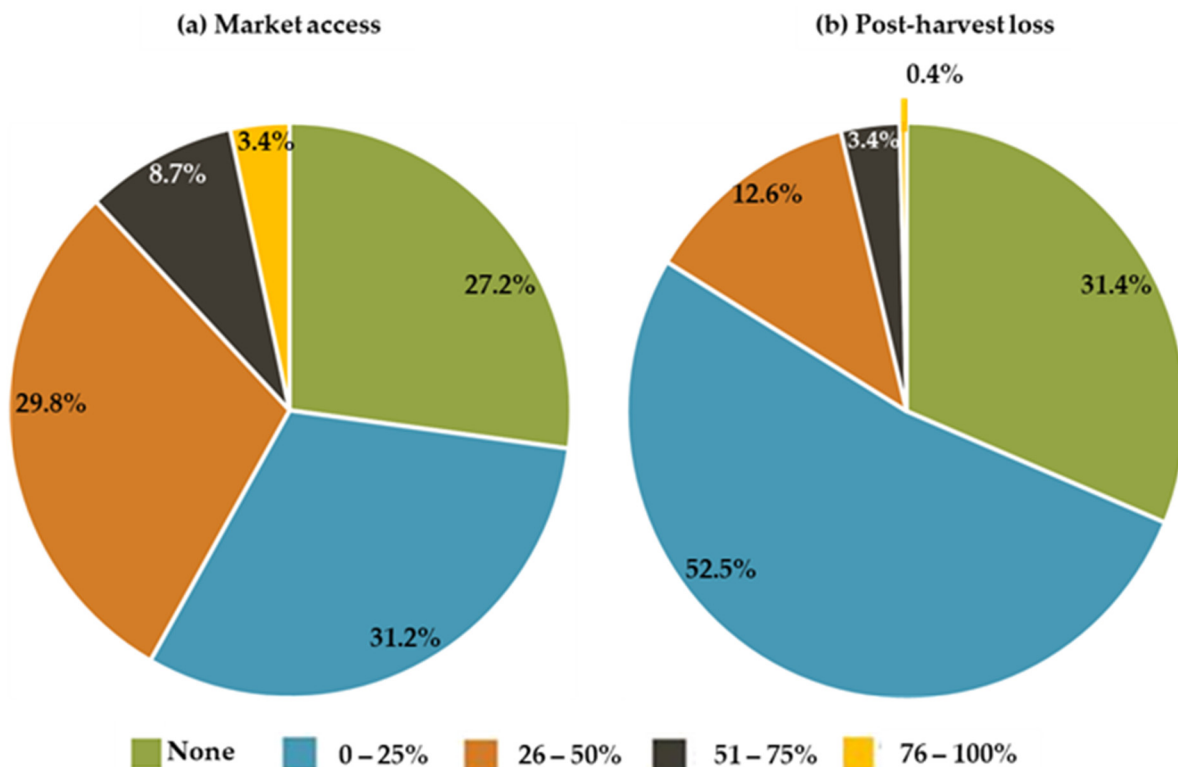
Livestock production is vital for livelihoods and survival for smallholder farmers in the arid areas where the pastoral farming system is prevalent. Due to limited care to animals for forage and additive feeds, many farmers lost production during the pandemic. Accordingly, 66.1% of respondents experienced some reduction in livestock production. A reduced number of animals, home consumption, and reduction in production occurred. The reduction in livestock production during the pandemic can be attributed to several factors. Inaccessibility of livestock feeds due to disrupted supply chains was one of the main drivers of reduction in livestock production [21]. Moreover, due to the lockdown, the national vaccine campaign for Peste des petits ruminants (PPR) was suspended, local veterinary services were shut down, and this had a severe impact on livestock health, leading to reductions in production [42]. The limited availability of animal monitoring staff magnified the impact of livestock health on their productivity.

### 3.3. Impact on Socio-Economic Conditions

#### 3.3.1. Impact on Markets and Supply Chains

The economic growth of Senegal increased from 2013 to 2017 due to the first phase of Plan Sénégal Emergent, the key national policy framework. However, from 2017 to 2020 annual growth in GDP declined from 7.4% to 0.87% [15]. In addition to these setbacks, another challenge of the pandemic struck Senegal in March 2020. To ensure the safety of citizens, several stringent measures were taken by the government that had impacts along the supply chain. Middendorf et al. [6] highlighted in their survey that 73.2% of respondents anticipated disruptions in local markets and supply chains. Our survey affirms

those perceptions. Figure 6a shows that 72.8% of respondents experienced difficulty in accessing markets at different scales.



**Figure 6.** Share of crop production sold at market (a), and post-harvest loss (b), due to COVID-19 among respondents ( $n = 802$ ).

The survey indicates that only 27.2% respondents did not experience difficulties with local farmer's markets. When we analyze and compare the share of crop production consumed at home with market accessibility (Figure 6a), we find that those who did not consume the share of production at home, either could have sold to the local market by securing supply for pre-season contract with dealers, or they might have faced post-harvest losses (Figure 6b) [21]. For horticultural or other perishable produce, post-harvest loss could mainly be due to the lockdown [26]. According to the survey, 68.6% respondents experienced crop production loss due to post-harvest issues (e.g., spoilage, spillage, overage) due to COVID-19.

**Table 6.** Thinking about your experience related to market issues, please indicate your level of agreement or disagreement with the following statements. COVID-19 has . . .

Statement	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Mean (SD)
Reduced access to getting my produce to the <i>local</i> market during this season.	34 (4.2%)	33 (4.1%)	49 (6.1%)	185 (23.1%)	501 (62.5%)	802	4.35 (1.05)
Reduced access to getting my produce to the <i>urban</i> market during this season.	30 (3.7%)	21 (2.6%)	60 (7.5%)	213 (26.6%)	478 (59.6%)	802	4.36 (0.99)
Reduced my ability to <i>transport</i> my produce to the market during this season.	25 (3.1%)	24 (3.0%)	59 (7.4%)	171 (21.3%)	523 (65.2%)	802	4.43 (0.97)
Reduced the number of <i>distributors</i> for my produce during this season.	43 (5.4%)	41 (5.1%)	108 (13.5%)	184 (22.9%)	426 (53.1%)	802	4.13 (1.15)
Increased <i>post-harvest loss</i> during this season (e.g., spoilage, lack of cold storage).	54 (6.7%)	73 (9.1%)	92 (11.5%)	176 (21.9%)	407 (50.7%)	802	4.01 (1.26)

Note: Means are on a 5-point scale (1 = Strongly Disagree to 5 = Strongly Agree).

Table 6 indicates that 85.6% and 86.2% of respondents experienced a reduction in access to getting their produce to local and urban markets, respectively, during the 2020 growing season. Mobility restrictions were the prime reason for this difficulty. Transport to local markets is done by donkeys and horses in rural Senegal. However, due to restrictions, 86.5% of respondents experienced a reduction in their ability to transport their produce to the market, 76% experienced a reduction in the number of distributors for their produce during this season, and 72.6% reported increased post-harvest loss (e.g., spoilage, and lack of cold storage) during the 2020 growing season. These percentages are the aggregation of the two response categories “somewhat agree” and “strongly agree.” (Table 6).

### 3.3.2. Impact on Labor Availability

The supply and demand for labor in the agriculture sector was greatly influenced by COVID-19 due to mobility restrictions. Accessibility to on-farm and off-farm labor was driven by lack of finances, inability to hire, and/or increased reliance on household members for labor. The industrial work stoppage forced urban labor to migrate to rural areas. Nonetheless, survey results indicate that 75.5% of respondents experienced reduction in access to labor due to a lack of finances during the 2020 growing season. Job losses in off-farm activities imposed financial strain on rural households, which led to a reduction in the accessibility of labor. About 60.6% of respondents experienced reduced access to labor due to a lack of individuals to hire, and 75.6% of respondents reported increased reliance on household labor during the pandemic. The savings crunch, credit limitations, and disrupted markets accompanied by the social stigma of the pandemic, forced individuals to not hire labor on their farms and rely on household members for on-farm and off-farm activities. These percentages are the aggregation of the two response categories “somewhat agree” and “strongly agree.” (Table 7).

**Table 7.** Thinking about your experience of what has occurred due to COVID-19, please indicate your agreement or disagreement with the following statements related to access to labor.

Statement	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Mean (SD)
Reduced access to labor due to a lack of <i>finances</i> during this season	85 (9.8%)	64 (7.4%)	63 (7.3%)	236 (27.2%)	418 (48.3%)	866	3.96 (1.31)
Reduced access to labor due to a lack of <i>individuals to hire</i> during this season.	161 (18.6%)	88 (10.1%)	92 (10.6%)	214 (24.7%)	311 (35.9%)	866	3.49 (1.51)
Increased reliance on <i>household labor</i> during this season.	52 (6.0%)	36 (4.2%)	123 (14.2%)	185 (21.4%)	470 (54.2%)	866	4.14 (1.17)

Note: Means are on a 5-point scale (1 = Strongly Disagree to 5 = Strongly Agree).

**Table 8.** If depending on off-farm labor, please indicate the level of access to labor throughout the agricultural cycle.

Off-Farm Labor Accessibility	Frequency ( <i>n</i> = 866) (%)
Much less	180 (20.8)
Somewhat less	221 (25.5)
About the same	77 (8.9)
Somewhat more	35 (4.0)
Much more	14 (1.6)
I do not depend on off-farm labor	339 (39.1)

If farmers depended on off-farm labor, they were asked additional questions related to the access to labor throughout the agricultural cycle and the ability to hire workers from within and outside their communities. In response to these questions, 39.1% of farmers indicated that they do not depend on off-farm labor. The responses are summarized in Table 8. Almost 60% of respondents indicated some scale of reduction in accessibility to off-farm labor throughout the agricultural cycle. Health care was a major concern for off-

farm labor accessibility. The International Labor Organization [43] estimated that globally ~1.6 billion informal workers (76% of informal employment) were impacted by pandemic related restrictions, and African countries were expected to have more job loss and labor issues in the informal sector [43]. They also forecasted that until the end of 2022, the younger workforce would continue to face these issues as developing countries like Senegal struggle to stimulate economic recovery.

The head of household hires off-farm workers in rural Senegal mainly from their community, the region, or from neighboring countries. Due to border closures, labor movement from other countries was restricted. Getting labor from the local community was more difficult due to mobility restrictions and health concerns of the laborers. Respondents were asked to select multiple options for the source of off-farm labor. As illustrated in Figure 7, 53.5% of respondents were able to hire workers from their community, 37.4% from their region, and 4.2% from other countries. The survey indicates that 67.9% of respondents experienced a reduction in labor accessibility (Figure 8). Specifically, they were asked if they were able to hire labor for planting and harvesting during the agricultural cycle, and 48.8% respondents faced problems in hiring laborers. Most of them managed through family members (women and children).

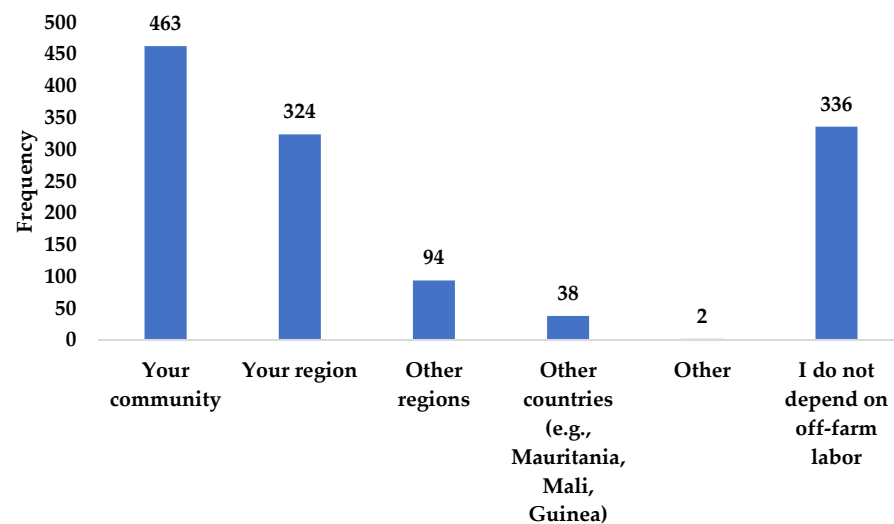


Figure 7. Ability to hire off-farm labor ( $n = 866$ ).

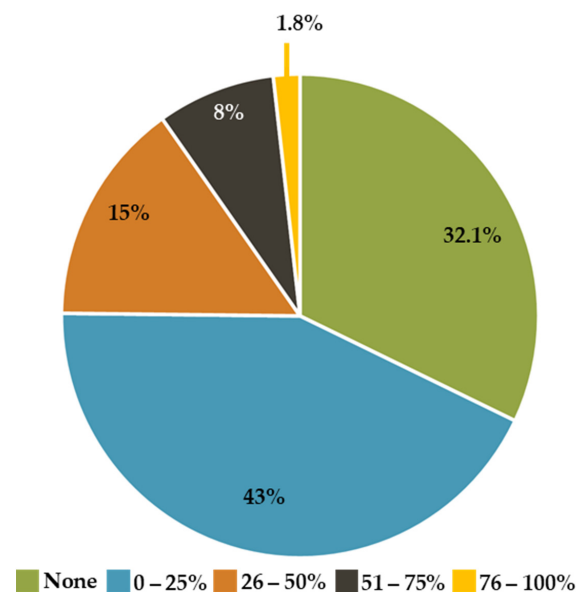


Figure 8. Reduction in labor accessibility.

### 3.3.3. Impact on Gender Equity

Gender disparity is a global phenomenon in the agricultural sector of developing countries, where women face resource constraints, contested ownership, and often a lack of decision-making power. These constraints can be alleviated by active participation in decision-making. In Senegal, women usually do household activities (e.g., family care, nutrition, marketing), take care of poultry and milking animals, and help in planting and harvesting during the growing season. Due to the pandemic, women farmers faced challenges in active participation in decision-making, allocation of farm resources, and lack of access to technical know-how [44,45]. The survey results illustrate the major impacts of COVID-19 on women. Respondents (83.2%) indicated that there was a significant increase in household activities (e.g., meal preparation, water collection, childcare), primarily due to more household members losing their jobs and staying at home due to mobility restrictions. It also led to an increase in domestic violence against women in Senegal [44]. Respondents (57.1%) indicated that there was a significant decrease in on-farm activities due to the increase in household activities and more family members at home due to curfews and travel restrictions. Regarding challenges for women and issues related to labor, most respondents received help from family members in on-farm activities due to the earnings shortage. However, 56.8% of respondents experienced a significant increase in off-farm activities (Table 9), based on the aggregation of the two response categories “somewhat agree” and “strongly agree”.

**Table 9.** Thinking about what occurred for women due to COVID-19, please indicate your one best response to the following statements . . . .

Statement	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Mean (SD)
There was a significant <i>increase</i> in women’s labor in the household (e.g., meal preparation, water collection, childcare, etc.).	43 (5.0%)	51 (5.9%)	51 (5.9%)	246 (28.4%)	475 (54.8%)	866	4.22 (1.11)
There was a significant <i>decrease</i> in women’s labor in on-farm activities (e.g., planting, weeding, irrigating, harvesting, etc.).	115 (13.3%)	166 (19.2%)	90 (10.4%)	218 (25.1%)	277 (32.0%)	866	3.43 (1.43)
There was a significant <i>increase</i> in women’s labor in off-farm activities (e.g., wage labor, market activities, etc.).	118 (13.6%)	134 (15.5%)	122 (14.1%)	156 (18.0%)	336 (38.8%)	866	3.52 (1.46)

Note: Means are on a 5-point scale (1 = Strongly Disagree to 5 = Strongly Agree).

Respondents were also asked to consider the multifaceted impacts of the pandemic on women. Women faced challenges in three aspects: (1) physical burden to support the head of household, (2) financial risk in view of low product sales, and (3) mental anxiety for children and dependents in the family. During the peak of COVID-19, women’s responsibilities multiplied. The key challenge was to support the head of household, which includes working on both the farm as well as in the home. This led to an overload in women’s daily activities as they had to work throughout the day, leading to physical stress. Further, because of the closure of local markets, sometimes they had to travel to distant markets to sell dairy and other agricultural products in addition to taking care of livestock at home. Due to the lockdown, women faced individual-level health resilience issues due to reduced access to health care with confinement. Along with physical stress, they also experienced financial burden due to the poor sale of agricultural products. Moreover, because of low-income flow, other women’s activities in terms of petty trading were suspended. They were also affected mentally due to concerns for child nutrition, their education, and the well-being of other dependents of the household.

### 3.3.4. Impact on Youth

Africa has youngest population in the world; however, two-thirds of the youthful population are either unemployed or forced into low wage jobs. Agriculture, which contributes more than 17% to Senegal’s GDP, has untapped potential for youth employment.



The pandemic has damaged agricultural systems by severely impacting supply chains. The persisting challenges of lack of financial support, land ownership, and technical training prevent youth from engaging in farming activities [46]. This trend improved during the pandemic, as many young farmers lost their off-farm jobs and focused on on-farm jobs [47]. The survey indicated that 62.7% of respondents experienced a significant increase in on-farm activities, while only 36.7% experienced significant increase in off-farm activities. These percentages are the aggregation of the two response categories “somewhat agree” and “strongly agree.” (Table 10).

**Table 10.** Thinking about what occurred for youth due to COVID-19, please indicate your one best response to the following statements.

Statement	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Mean (SD)
There was a significant <i>increase</i> in local youth’s labor with <i>on-farm</i> activities (e.g., weeding, planting).	80 (9.2%)	156 (18.0%)	87 (10.0%)	216 (25.0%)	327 (37.7%)	866	3.64 (1.37)
There was a significant <i>increase</i> in local youth’s labor with <i>off-farm</i> activities (e.g., wage labor, market activities).	206 (23.8%)	186 (21.5%)	156 (18.0%)	136 (15.7%)	182 (21.0%)	866	2.88 (1.46)

Note: Means are on a 5-point scale (1 = Strongly Disagree to 5 = Strongly Agree).

The survey also asked open-ended questions about the greatest challenges that COVID-19 posed for youth in their households and community. The pandemic impacted the lives of youth in a multitude of ways. The top challenges included: (i) unemployment, (ii) cessation of agricultural and production activities, (iii) lack of access to resources necessary for survival, and (iv) reduction in purchasing power. While there were young people who returned to villages and confined themselves, some emigrated to find work, legally or illegally. Owing to unemployment, travel restrictions and a lack of other resources, a significant proportion of youth was stranded in villages and tried consistently to move to urban areas of Europe in search of income-generating activities. Youth who used to work in fields were looking for jobs in the factories, industries, or completely new areas to ensure some source of income which would help them satisfy their basic needs. There was a strong initiation of young people into production activities and the management sector. Some respondents lacked access to the internet, difficulty in accessing Wi-Fi hotspots, a lack of digital access to take online courses and weak computing infrastructure. Overall, youth in Senegal were striving to participate in the holistic development of the community, seek employment, provide for their own needs and search for alternative sources of income.

### 3.4. Short Term Resiliency in Adapting to COVID Related Shocks

#### 3.4.1. Change in Cropping System, Practices, and Calendar

Senegal relies heavily on the import of agro-chemicals and hence is vulnerable to the socioeconomic impacts of the pandemic due to supply chain problems. With growing data on evaluating the impacts, robust policy can be designed. To date researchers have designed sporadic and patchwork plans without any long-term resilient mechanisms. However, based on resource availability, growers have adapted their crop plans and associated decisions on-farm and off-farm. Hence, the survey explored household experiences and in-season adjustments in their crop types, practices, and calendar. Latané et al. [21] highlighted that rural households were worried that their food stock would run out if they did not receive food aid from the government or other agencies. Thus, they used most of their credits in planning to grow enough food on time. Ninety five percent of respondents did not change crop type, practices, or the cropping calendar. However, of 5% who changed their crop type, 60% of them shifted to vegetables to diversify their farm and 40% shifted to less perishable alternative of cereal crops. In practice, they shifted to fast-growing vegetables and applied organic manure instead of synthetic fertilizer, and this might be attributed to the closure of markets and unavailability of fertilizers. They also faced labor shortages;

hence, field preparation jobs were performed by household members. They shifted to short duration crops and thus modified the planting and harvesting calendar.

Respondents were also asked to share their relationship with the farmers organizations. Their membership in different organizations helped them in coping strategies such as utilization of social capital, resource allocation, and additional well-being support for strengthening household-level and community-level resilience capacity [21]. A large majority (82%) of respondents indicated having a strong relationship with farmers organizations, and 53% of these considered themselves frequently involved with their organizations (Table 11).

**Table 11.** Involvement with farmer organization.

Frequency of Engagement	Frequency ( <i>n</i> = 804) (%)
Always	168 (20.9)
Most of the time	258 (32.1)
About half the time	81 (10.0)
Sometimes	193 (24.0)
Never	102 (13.0)

The data indicated that 75.5% of respondents experienced significant disruptions in extension and advisory services, while 74.1, 51.7, and 50.1% faced communication barriers through organization, phone, and radio/television, respectively, during the pandemic. These percentages are the aggregation of the two response categories “somewhat agree” and “strongly agree” (Table 12). Farmer’s extension services helped in the timely dissemination of knowledge and services related to weather advisories. However, due to mobility restrictions, most of the information related to animal disease monitoring and chemical applications on crops was not delivered to growers. Crop yield losses might be attributed to these factors. With a diverse agriculture sector, extension through telecommunication is not a one-size-fits-all delivery of information. These barriers were overcome by some farmers’ groups who managed extension services well in different parts of Senegal [21].

**Table 12.** Thinking about what occurred due to COVID-19, please indicate your level of agreement for each of the following statements.

Statement	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Mean (SD)
There were significant disruptions in <i>extension and advisory</i> services for farmers.	22 (2.7%)	56 (7.0%)	119 (14.8%)	161 (20.1%)	444 (55.4%)	802	4.18 (1.09)
There were significant disruptions in <i>communication</i> from farming organizations/networks	26 (3.2%)	69 (8.6%)	113 (14.1%)	167 (20.8%)	427 (53.3%)	802	4.12 (1.13)
There were significant disruptions in <i>receiving</i> information via cell phone	128 (16.0%)	120 (15.0%)	139 (17.3%)	146 (18.2%)	269 (33.5%)	802	3.38 (1.47)
There were significant disruptions in <i>receiving</i> information via radio and/or television.	112 (14.0%)	140 (17.5%)	148 (18.4%)	125 (15.6%)	277 (34.5%)	802	3.39 (1.45)

Note: Means are on a 5-point scale (1 = Strongly Disagree to 5 = Strongly Agree).

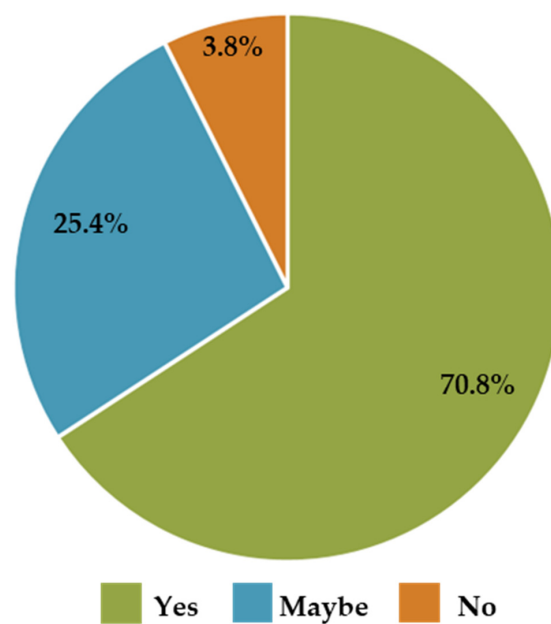
### 3.4.2. Livelihood and Social Well-Being Interventions

During the pandemic, food stocks in the household, and receiving food aid, were two major concerns among respondents regarding food security. On average, cereal stock in Senegal is ~8 kg/month/person as of 2017 [21]. The survey results indicate that 85.9% of respondents experienced difficulty in getting enough food for their household on a regular basis. The closure of local markets to buy and sell produce, can create price volatility and inflation. About 92.9% and 89.6% of respondents experienced local closures of markets where they purchase and sell produce respectively, and 79.1% faced price increases due to market disruptions. These percentages are the aggregation of the two response categories “somewhat agree” and “strongly agree” (Table 13).

**Table 13.** Thinking about what occurred due to COVID-19, please indicate your one best response to the following statements.

Statement	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Mean (SD)
Getting <i>enough food</i> on a regular basis for my household became more difficult	17 (2.0%)	39 (4.5%)	66 (7.6%)	213 (24.6%)	531 (61.3%)	866	4.39 (0.94)
The market where I purchase food for my household was either <i>closed or significantly</i> disrupted	16 (1.8%)	11 (1.3%)	34 (3.9%)	214 (24.7%)	591 (68.2%)	866	4.56 (0.78)
There was a significant increase in the <i>price of foods</i> that I purchased for my household	15 (1.7%)	41 (4.7%)	124 (14.3%)	205 (23.6%)	481 (55.5%)	866	4.27 (0.98)
The market where I sell the produce/ livestock from my farm was either <i>closed or significantly</i> disrupted.	13 (1.5%)	10 (1.2%)	67 (7.7%)	203 (23.4%)	573 (66.2%)	866	4.52 (0.82)

Note: Means are on a 5-point scale (1 = Strongly Disagree to 5 = Strongly Agree).

**Figure 9.** Impact of COVID-19 on the following agricultural season.**Table 14.** Thinking about your experiences of what occurred due to COVID-19, please indicate your level of agreement for each of the following statements.

Statement	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Mean (SD)
I did not have access to <i>other social services</i> to help my household	414 (47.8%)	163 (18.8%)	36 (4.2%)	66 (7.6%)	187 (21.6%)	866	2.36 (1.62)
I did not have access to <i>farm credit</i>	413 (47.7%)	159 (18.3%)	49 (5.7%)	55 (6.3%)	190 (22.0%)	866	2.36 (1.62)
I did not have access to <i>subsidies</i>	439 (50.7%)	101 (11.7%)	28 (3.2%)	89 (10.3%)	209 (24.1%)	866	2.45 (1.70)
I did not have access to <i>other financial supports</i>	563 (65.0%)	146 (16.9%)	52 (6.0%)	24 (2.8%)	81 (9.3%)	866	1.75 (1.26)

Note: Means are on a 5-point scale (1 = Strongly Disagree to 5 = Strongly Agree).

Amidst growing food insecurity, market disruptions, and price volatility, respondents were asked if they expect to face any consequences in the next agricultural season; 70.8% said “Yes,” and 25.4% said, “Maybe” (Figure 9). This indicates uncertainty among respondents regarding ongoing economic impacts of COVID-19 on next year’s agricultural cycle. Robust policy support could curtail these uncertainties and vulnerabilities. Interestingly, the results indicated that 66.6% of respondents had access to other social services to help their household, 66% had access to farm credits, 62.4% had access to subsidies, and

81.9% had access to other financial supports. These percentages are the aggregation of the two response categories “somewhat disagree” and “strongly disagree.” (Table 14).

For smallholder farmers, financing is primarily used for agricultural production (e.g., purchase of inputs, labor), and thus is a critical form of support. In light of the disruptions of the pandemic respondents considered calibrating their plans for the next agricultural year. For example, 69.6% of respondents planned to make changes in their agricultural practices next year, 67% respondents would diversify crops next season to balance between food security and financial security by focusing more on exporting high value cash crops, 77% of respondents said they would take precautions against future disruptions in terms of finances and resources associated to on-farm and off-farm activities, and 76% of respondents said they would engage more with service organizations for support for finance and farm advice. Latané et al. [21] highlighted the role of farmers’ networks and organizations in short term resiliency of households against COVID-19 in Senegal, especially in providing accessibility to inputs and financing. These percentages are the aggregation of the two response categories “somewhat agree” and “strongly agree.” (Table 15).

**Table 15.** Thinking about your experience of what has occurred due to COVID-19, please indicate your agreement or disagreement with the following statements related to what you would do differently for the next agricultural cycle if anything.

Statement	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Mean (SD)
I would make <i>some changes</i> to my agricultural practices	108 (14.0%)	31 (4.0%)	95 (12.3%)	185 (24.1%)	350 (45.5%)	769	3.83 (1.40)
I would <i>increase</i> the <i>diversity</i> of crops; I plant and produce	122 (15.8%)	35 (4.6%)	97 (12.6%)	223 (29.0%)	292 (38.0%)	769	3.69 (1.42)
I would <i>increase</i> my <i>precautions</i> against future disruptions in terms of finances and resources (e.g., on-farm and off-farm activities)	38 (5.0%)	31 (4.0%)	108 (14.0%)	200 (26.0%)	392 (51.0%)	769	4.14 (1.11)
I would engage <i>more</i> with <i>service organizations</i> for support (e.g., farmers, financial, advisory)	35 (4.6%)	25 (3.3%)	124 (16.1%)	158 (20.5%)	427 (55.5%)	769	4.19 (1.10)

Note: Means are on a 5-point scale (1 = Strongly Disagree to 5 = Strongly Agree).

#### 3.4.3. Policy Support

The impact of COVID-19 on farming systems varies geographically with multiple dimensions, and hence, one uniform policy cannot fit all cases. The microeconomic impact on smallholder farmers can be eased by food aid and family support such as on-farm labor. However, high cash value export-oriented crops were more exposed to international trade disruption, supply, and finance shocks. As current and post-pandemic economic recovery progresses, short-term and long-term policy measures for resilient systems are needed, including investment mobilization to minimize the financial gap. The major short-term policy support in Senegal was to strengthen small and medium enterprises to provide off-farm jobs to households who were laid off due to disruptions. The associated debt finance, employment support, tax, and business advice offered transient financial stability [10]. To minimize the impact of the pandemic on household nutrition, the Ministry of Agriculture and Rural Equipment (MAER), together with global development agencies, started the “Housewives’ Basket” initiative in Senegal. The Senegalese government has also revised the second phase of Senegal Emergent Plan to steer funding towards the promotion of intensive and resilient farming systems.

The FAO has launched the “Household Food Basket” initiative using its anticipatory action fund in Senegal to strengthen the resilience of smallholder farming systems and to protect food supply chains [11]. It created a digital platform where small entrepreneurs can engage in trade, which boosted women food processors and local economies along with efforts on food aid focused on child nutrition [12]. The World Bank’s International Development Association (IDA) supported Senegal with USD 150 million credit to strengthen

and build resilient agricultural systems [9]. World Food Program (WFP), through the R4 Rural Resilience Initiative, helped hundreds of households in building resilient food systems through weather insurance and the creation, with smallholder farmers, of village cereal banks for meal plans for school kids [13]. To mitigate the impact of COVID-19, the International Fund for Agricultural Development (IFAD) in coordination with the FAO, WFP, and the Green Climate Fund (GCF) revitalized economic activities for Senegal [14]. Peace Corps Senegal, in collaboration with the USAID Feed the Future program, supported the Master Farmers program during the pandemic via its sustainable rural agriculture extension agents' network.

#### 4. Conclusions

The COVID-19 pandemic disrupted markets, supply chains, and labor availability, which severely impacted smallholder farming systems in Senegal. The main objectives of this study were to explore the actual experiences of smallholder farmers in Senegal with COVID-19, how those experiences impacted their systems, and how farmers developed short-term adaptive capacities. The survey results indicated that the major impacts of the pandemic on smallholder farmers more likely came from disrupted supply chains and mobility restrictions. However, we also recognize that there were other subtle and indirect impacts on smallholder farming systems. Given the connecting links between the pandemic and its multifaceted drivers, we concluded that a detailed quantitative and qualitative assessment of the impacts was needed to capture the impacts of the pandemic on smallholder farming systems. This survey helped us to identify risk factors, gauge the adaptive capacity of rural households and enumerate the initiatives and policy support to strengthen resilience of farming systems.

The survey results captured the experiences of respondents during the pandemic and indicate a need to address these concerns to mitigate the impacts of future shocks. However, as with any research, there are some limitations to this study. First, because the survey was conducted by cellphone, those smallholders without cellphones could not be reached. Further, the sample is majority male, thus the experiences and perceptions of women are somewhat underrepresented in this data. Finally, this study was considered an initial baseline. Follow-up research would include more formal analyses, as well as in-depth interviews with a subset of respondents to further verify the data.

The biophysical (crops and livestock) and socioeconomic (labor, market, gender, and well-being) impacts on farming systems during the pandemic call for significant concerns about the precariousness of the situation, as well as concerns with policy planning. Further research on the short-term and long-term impacts on rural livelihoods as well as policy implications is warranted. This study will assist researchers in measuring the vulnerability of households to shocks and mitigate the impacts for improved and resilient smallholder farming systems. The baseline survey obtained from this study will be valuable to policymakers and other stakeholders to design mitigation strategies for resilient smallholder farming systems.

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