Conditional Contracts in Indirect Local Procurement

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Abstract

Since 2004, the World Food Programme (WFP) has increasingly recognized its potential to support local market development by improving small-scale traders' and farmer organizations' access to stable and profitable markets. In 2019, WFP introduced the Local and Regional Food Procurement Policy (LRFP), a strategic initiative designed to enhance procurement efficiency through greater engagement with private sector actors, while also promoting broader development objectives such as improved nutrition, resilience, smallholder incomes, livelihoods, and gender equality. A key feature of the LRFP is the use of indirect conditional contracts, which require that large traders, acting as intermediaries in WFP's supply chain, procure a specified share of their contracted volume directly from smallholder farmers. This report draws on systematically collected survey data from farmers and aggregators in western Uganda to evaluate the extent to which the LRFP policy has contributed to these objectives and helped drive transformation in local agricultural value chains.

1 Introduction

In crisis situations such as armed conflicts or natural disasters, timely food aid plays a critical role. It not only prevents famine and acute malnutrition in the short term, but also protects households from depleting their assets, thereby reducing long-term hardship (Dercon, 2002). The United Nations World Food Programme (WFP) is at the forefront of these efforts, leveraging a vast

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logistics network of up to 5,000 trucks, 80 aircraft and 20 ships in motion daily to deliver food assistance on an immense scale, reaching 152 million people in 2023 alone (WFP, 2023). In war-torn nations like Syria and Yemen (with conflicts beginning in 2011 and 2015, respectively), WFP has sustained millions of people with staple foods month after month, peaking at about 5.6 million recipients per month in Syria and 13 million in Yemen during the worst periods of conflict. The impact of such timely assistance is evident: a famine that emerged in South Sudan in early 2017 was ended within four months due to a concerted large-scale humanitarian response. WFP has also been crucial in sudden natural disasters – for instance, after the February 2023 earthquake in Syria and Turkey, it rapidly provided hot meals and ready-to-eat rations to survivors cut off by the destruction.

Traditionally, WFP obtained the food it distributed directly from donor countries. Tied aid such as this has faced increasing criticism since the late 20th century for its economic inefficiency and negative impacts on recipient countries. The shift towards untied aid gained momentum with international agreements like the 2005 Paris Declaration on Aid Effectiveness, advocating for aid that aligns more closely with the development priorities of recipient countries. WFP followed this trend and started relying more and more on local purchases (that is, in the affected country) or regional purchases (that is, in a neighboring country or a third country in the region) of the food it needs for its food aid operations.

Uganda, a stable country in a conflict-prone region, has become a crucial player in WFP's efforts to combat food insecurity. As the largest buyer of food commodities in low- and middle-income countries, WFP injected $50 million into Uganda's economy in 2018, purchasing significant quantities of maize, sorghum, and beans. Various WFP initiatives, such as the Purchase for Progress (P4P) pilot, aim to enhance market access for smallholder farmers, improve agricultural outcomes, and foster equitable growth within local food markets. However, impact evaluations paint a mixed picture and challenges—such as for instance higher costs, market fragmentation and high quality requirements—persist (Lentz and Upton, 2016; Gelo et al., 2020). Recent policy shifts towards indirect conditional contracts, which are agreements between WFP and wholesale maize traders requiring that a portion of procurement be sourced directly from smallholder farmers, aim to leverage the private sector to better integrate these farmers into the supply chain and ensure they benefit more from WFP's stable demand in a more efficient and effective way.

Maize, one of the most extensively cultivated staple crop in Uganda, occupies about 30% of the country's cropped land, serving as both a critical food security crop and a vital source of income for farmers. The government has prioritized maize production in its agricultural strategy to enhance national food security and support household livelihoods. The maize value chain in Uganda involves numerous interconnected actors, from agro-input dealers who supply essential inputs like seeds and fertilizers to smallholder farmers, over aggregators and wholesale traders, to processors who turn the harvested maize into products like flour for consumer purchase.

Despite government efforts to promote modern agricultural practices, many farmers continue to rely on traditional methods and face challenges such as access to quality inputs, low productivity, and inefficient post-harvest handling that leads to significant losses. These issues, coupled with inefficient market access and processing capabilities, stifle the overall competitiveness of Uganda's maize sector. Aggregators play a crucial role in linking farmers to markets and enhancing market participation, even as the sector grapples with challenges in storage, transportation, and price fluctuations influenced by seasonal and regional dynamics (Sitko and Jayne, 2014a).

This report utilizes observational data that was collected from a stratified sample of about 300 (mostly small) aggregators and 1300 farmers. We also collected qualitative data from wholesalers. Extensive exploratory and descriptive analysis is used to identify patterns in the data, while econometric techniques such as instrumental variables is applied in an attempt to attribute causality to the correlations and isolate the effect of WFP's Local and Regional Food Procurement Policy from other factors.

The main findings of this study are that WFPs activities seem to have benefited farmers, who receive higher prices for the maize they sell. Aggregators, on the other hand, report receiving lower prices for the maize they sell onward to WFP connected wholesalers. This seems to suggest that the policy does not make grain more expensive for WFP; in fact, the policy seems to attract more aggregators, leading to increased competition which in reduces rent extraction in this section of the value chain. In addition to these large and significant price effects, we also find that the policy accelerates agricultural technology adoption among farmers, partly because aggregators provide access to these inputs. Aggregators also invest more in quality as a result of WFP presence.

The remainder of this report is structured as follows. We begin with an explanation of the new procurement modality. Next, we provide an overview of Uganda's maize sub-sector, highlighting the roles of farmers, aggregators, and wholesalers within the value chain. The methods section then outlines the research questions and describes how these are addressed using stack survey data. This is followed by the results, starting with a descriptive analysis and then moving to a more analytical section that explores potential causal relationships. The report concludes with a summary of key findings and policy recommendations based on the evidence.

2 WFP Conditional Contracting

Uganda is a relatively stable country in a region affected by conflict and food insecurity (Upton and Hill, 2011). As a result, it is a key contributor to the World Food Programme (WFP), the world's largest humanitarian organization, which buys more food commodities for its food assistance programs from Uganda than from any other low- and middle-income country. In 2018, WFP invested 50 million USD in the Ugandan economy and purchased over 188,000 metric tons of local food commodities—mainly maize, sorghum and beans—

through open tendering from large traders (World Food Programme, 2019). WFP's food assistance programs support disadvantaged populations, including food-insecure households, young children and refugees and internally displaced persons. In Uganda, these programs help address food insecurity and malnutrition and support the growing refugee population while bolstering the country's national social protection system. This is important given that Uganda is currently Africa's largest refugee hosting country (Global Compact on Refugees, 2018).

Smallholder farmers have been a core focus of WFP's procurement policies for at least two decades. In 2004, the "Food Procurement in Developing Countries" policy was initiated, recognizing the role WFP had to play in developing markets, supporting small traders and farmers' groups and using procurement to encourage smallholder farmers and farmer groups to enter reliable and lucrative markets (World Food Programme, 2006). In 2007, WFP's Home-Grown School Feeding (HGSF) program was launched with the support of the Bill and Melinda Gates Foundation, once again emphasizing the need for local procurement from small producers. Building on the HGSF but greatly expanding its scope and ambition, WFP then launched a 20-country pilot of its Purchase for Progress (P4P) initiative in the wake of the 2007-08 food price crisis. P4P explored procurement modalities with the potential to improve agricultural outcomes and develop country-level food markets in a way that would benefit smallholder farmers (World Food Programme, 2015).

Uganda was one of the pilot countries for the P4P initiative, along with Ethiopia, Kenya, Rwanda, South Sudan and Tanzania in east Africa, and other countries in central, southern and western Africa, Asia and Latin America. Evidence of the impacts of the P4P initiative is mixed: early studies indicate that it improved farmers' access to markets and post-harvest handling (Gelo et al., 2020; Davies and Menage, 2010 as cited in Upton and Hill, 2011) and improved gender equity (World Food Programme, 2015), though Lentz and Upton (2016) do not find evidence of improved farmer wellbeing in the context of Tanzania despite greater commercialization. In Uganda specifically, large-scale local procurement by WFP appears to have accentuated price speculation among traders and resulted in an equilibrium where two types of maize quality exist: high quality, sold to WFP, and low quality, directed towards the local market (Upton and Hill, 2011).

Despite the fact that 80-90% of food procured was produced by smallholder farmers, WFP procures only a small fraction directly from smallholder farmers via farmer organizations (Leao et al., 2021). An analysis of Uganda's maize value chain revealed fragmentation, lack of integration among players and lack of credit and access to transport for farmers (World Food Programme, 2019). Using regular contracts and open tendering with large traders resulted in about 50% of the cash (market value) reaching smallholder farmers, suggesting that employing both indirect and direct pro-smallholder contract modalities could address imbalances in the maize value chain, potentially increasing benefits for smallholder farmers (Leao et al., 2021). To tackle this, WFP shifted to various contract modalities including both direct and indirect conditional contracts to ensure that smallholder farmers benefit from WFP's stable demand (World Food Programme, 2019).

WFP's current Local and Regional Food Procurement Policy (LRFPP) policy was approved in 2019 and began being implemented in 2020 (World Food Programme (WFP), 2024). Uganda was one of the first countries to implement the indirect conditional contracts to procure maize—a key component of the LRFPP instituted in 2021. Conditional indirect contracting generally follow the same principles as traditional contracting, where purchases are announced in the form of national tenders that specify quantity and quality. However, under this type of contract, the condition is added that 20% of the total volume of maize provided by traders must be sourced directly from smallholder farmers, with evidence of purchase (traceability evidence). This conditional contract is the focus of this study.

3 Context and description of maize value chains in Uganda

Maize is one of the most widely cultivated staple crops in Uganda, serving both as a vital food security crop and a key source of income for farmers. Recognizing its importance, the government has prioritized maize production as part of its agricultural strategy to support household livelihoods and strengthen national food security. Maize accounts for approximately 30% of the total cropped land in Uganda, making it the most extensively grown crop, followed by beans at 15% (Uganda Annual Agricultural Survey, 2018).

A typical maize value chain in Uganda involves a network of interconnected actors. At the upstream level, agro-input dealers supply essential inputs such as seed of improved varieties and fertilizers to smallholder farmers. These farmers, in turn, cultivate maize by combining these inputs with land and labor. Once harvested, a marketable surplus is sold to aggregators (often at the farm gate of in local markets), who transport the grain using bicycles or motorcycles to wholesalers or directly to large processors. Wholesalers generally sell to large processors. Farmers may also take part of the maize they consume themselves to small processors. Processors then transform the raw maize into final products, such as maize flour, which is distributed to retailers and ultimately purchased by consumers. Figure 1 provides an illustration of a stylized maize value chain in Uganda.

Most farmers in Uganda continue to rely on traditional farming methods with limited use of modern agricultural inputs. While some purchase improved seed varieties, such as hybrids or open-pollinated varieties (OPVs), many still depend on saved seeds from previous harvests, constraining potential yield improvements (McGuire and Sperling, 2016). Despite government efforts to promote input use, challenges related to affordability and accessibility persist. Agro-input dealers, primarily based in towns and trading centers, supply essential inputs such as improved seeds, fertilizers, pesticides, and farming tools. However,

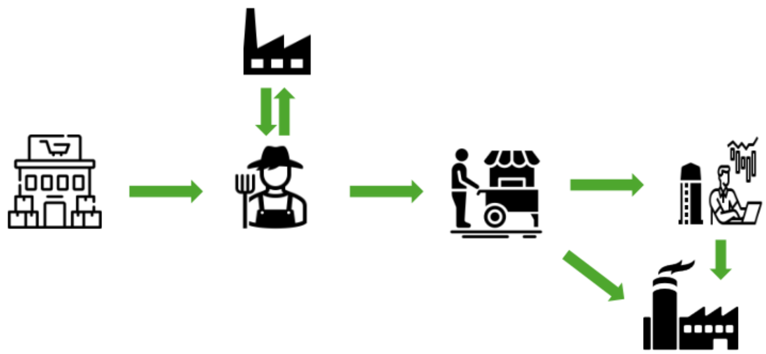

Figure 1: A canonical maize value chain

rural farmers often struggle to access high-quality inputs due to distance, cost barriers, and supply chain inefficiencies. Additionally, concerns over counterfeit or substandard products further discourage investment in improved technologies, as studies have shown that input quality issues are a significant deterrent for farmers (Barriga and Fiala, 2020; Ashour et al., 2019; Bold et al., 2017; Miehe et al., 2023).

As a result of traditional farming methods, maize productivity remains low, with average farm yields of about 600 kg per acre, considerably lower than the potential yields reported by research stations, which range from 730 kg to 1,820 kg per acre (Fermont and Benson, 2011; Gourlay, Kilic, and Lobell, 2019). Furthermore, harvesting in Uganda is largely manual, and post-harvest handling remains a significant challenge. Farmers typically dry maize under the sun before shelling and storing it, but inadequate drying techniques and poor storage facilities lead to high post-harvest losses. Common storage methods include traditional granaries and polypropylene bags, though both are vulnerable to pest infestations and moisture buildup, further deteriorating grain quality. These post-harvest inefficiencies contribute to reduced market value and increased vulnerability to seasonal price fluctuations.

Market access is another key challenge for maize farmers. Many smallholder farmers sell maize through informal channels, including farmgate sales to itinerant traders who aggregate maize in trading centers and small towns. These small traders, often using bicycles or motorbikes (boda-bodas), play a crucial role in linking farmers to markets, yet their capacity is constrained by transportation limitations, storage capacity challenges, credit constraints and unpredictable demand.

The role of aggregators is often contested, and indeed many development interventions supported by NGOs try to "cut out the middlemen". This is because traders, both small and large, also engage to some extent in arbitrage to capitalize on price seasonality, buying up maize grain from farmers immediately post harvest when prices are low and selling during the lean season when maize is scarce and prices are high (Van Campenhout, Lecoutere, and D'Exelle, 2015a; Burke, Bergquist, and Miguel, 2019). At the same time, research also shows that traders enhance market participation, particularly for remote farmers who would otherwise struggle to sell their produce (Barrett, 2008a; Mather, Boughton, and Jayne, 2013; Sitko and Jayne, 2014b).

Processing is another critical node in the value chain, where maize is transformed into flour, primarily consumed as *posho*—a staple dish made by cooking maize flour with water into a porridge. Processing businesses vary widely, from small-scale mills powered by combustion engines (*baga-baga*) that provide milling services for local farmers to large-scale industrial processors that produce fortified maize flour for commercial distribution. High-quality maize flour production requires multiple milling passes and advanced machinery, with some mills equipped for packaging and export.

WFP enters the value chain between the wholesaler and processor nodes. Their tenders target wholesalers that are able to meet both quantity and quality requirements. In practice, this means that wholesalers on a list of pre-qualified wholesalers get an invitation to bid on the tender. If selected, these wholesalers then supply WFP (usually in addition to other buyers). The wholesalers are required to demonstrate that 20% of the maize that they deliver to WFP was sourced directly from smallholders through documentation. This means that if these wholesaler work with aggregators, the aggregators also need to be able to demonstrate the source of their maize.[1]

4 Methods

4.1 Research questions

The primary goal of the study is to assess the overall impact of WFP entering the market and implementing the indirect conditional contracting modality. We will thus look at the impact of the policy on maize value chain transformation or upgrading. Within this broader goal, our study poses the following research questions:

- Does WFP's indirect conditional tendering approach lead to reliable output markets and how does this affect market participation, technology adoption, production and welfare outcomes for actors involved in the value chains?

- Does the presence of WFP with its conditionality affect value chain inclusivity and equity? That is, are there changes in which actors participate in the value chains and which actors extract most of the rents when WFP enters the market with conditionality? Do marginalized populations get

[1] Qualitative evidence suggests that this requirement was not always rigorously enforced.

excluded when WFP starts procuring large quantities of maize? Does it affect seasonality?

In addition to looking at the impact of the policy, we will also investigate potential general equilibrium or spillover effects of the policy. In particular, the indirect conditional contracting may drive up prices in the area, such that farmers that are not linked to WFP through an aggregator are also affected.

4.2 Data and identification

The study took place in Western and Central Uganda (see Figure 2). Maize cultivation plays a vital role in the agricultural landscape of Western and Central Uganda. In these regions, maize is widely grown by smallholder farmers who rely on it for household consumption, income generation, and food security. Additionally, the growing demand for maize from urban markets and agro-industrial processors (both for consumption in Uganda or neighboring countries) has increased its commercial value, in some instances encouraging investments in improved production practices and inputs and in storage, handling and aggregation midstream.

The survey for the study of conditional contracts aimed to gather data from three distinct types of actors: smallholder farmers, small aggregators who act as intermediaries between these farmers and wholesalers, and the wholesalers that are supplying WFP and/or processors or other large buyers. In a first step, farmers were selected randomly after stratifying them into three groups:

- Group 1: Farmers residing in two districts (Kabarole and Hoima) where WFP was not actively procuring maize through large buyers. Farmers in these two districts were randomly selected in two stages: first villages 50 villages were selected from a list of all villages, with sampling probabilities proportional to the number of households living in the village. Next, in each village 10 households were randomly selected from the list obtained from the village headquarters. This group will also be referred to as the control group.

- Group 2: Farmers who live in districts with characteristics similar to those in Group 1, but where maize is procured from farmers under the indirect conditional contract modality. Specifically, we sample from four districts: Kasese, Kyegegwa, Kiryandongo, and Masindi. Kasese and Kyegegwa are located in the southwestern corner of the study area near Lake George and border Kabarole district. Kiryandongo and Masindi lie in the northern part of the study area, at the northeastern tip of Lake Albert, adjacent to Hoima district. In these districts, farmers are sampled from lists submitted to WFP by wholesalers, as part of the contractual requirement to document purchases directly from farmers. This group will also be referred to as the indirect contracts or treatment group.

- Group 3: Farmers from the same four districts as group 2, but who are not on the traceability list of WFP linked suppliers. In particular, the

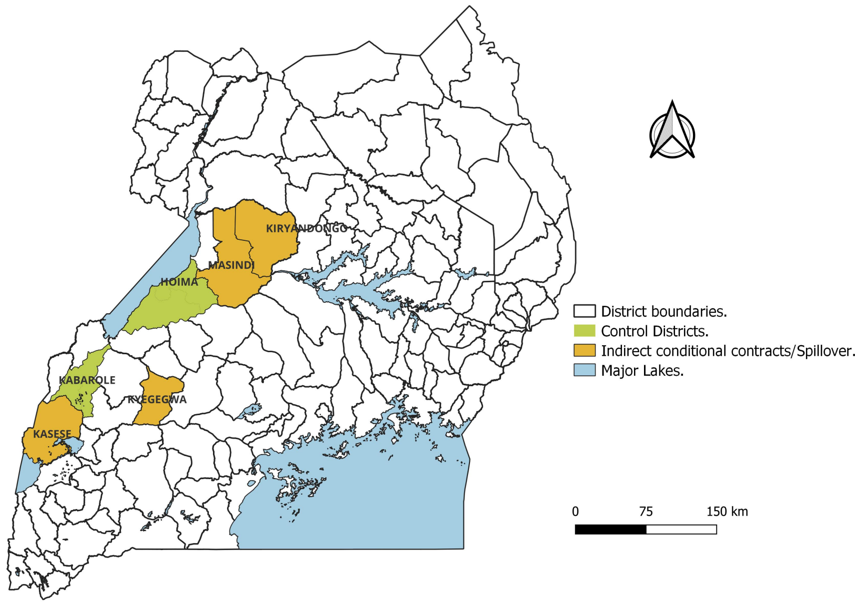

Figure 2: Study area

interview protocol stipulated that nearest neighbor of each Group 2 farmer also needed to be interviewed. This group will also be referred to as the spillover group.

Aggregators were identified through referral by farmers. For aggregators, we only have two groups: those that are operating in areas where WFP was active and those that are operating in areas where WFP is not active. Sample sizes are in Table 1.

The primary identification strategy relies on comparing average outcomes across the three farmer groups for farmer-level indicators, and across two aggregator groups for aggregator-level outcomes. At the farmer level, we estimate the impact of WFP's procurement through the indirect conditional contract modality by comparing farmers in treatment areas (Group 2) to those in control areas (Group 1). To explore potential spillover effects, we compare outcomes between farmers in Group 2 to those in the same area but not directly liked to WFP linked aggregators (Group 3). At the aggregator level, we simply compare outcomes in the control area to outcomes of aggregators operating in the areas where WFP is active.

It is important to note that the groups we specify are likely to be only proxies to the latent variables we would need to answer the research questions in Section 4.1. For instance, some farmers in Group 1 may in fact be selling to aggregators or traders linked to WFP. Conversely, not all farmers in Group 2 necessarily sold to WFP-linked buyers in the season under analysis, as inclusion in this

Table 1: Achieved samples of maize farmers and aggregators by stratification group

Group/Farmer type	**Achieved sample**	**Men**	**Women**	**Achieved sample**	**Men**	**Women**
Group 1: Conditional contract farmers	392	176	216	143	139	4
Group 2: Spillover farmers	389	178	211			
Group 4: Control group farmers	503	270	233	154	147	7
Total	1,284	624	660	297	286	11

group was based on having appeared on a procurement list in any season.[2] Similarly for aggregators, some aggregators that collect maize in control areas may actually ship to wholesalers that are supplying WFP, while aggregators located in areas where WFP procures may actually sell to a wholesaler that has now WFP link. Some of these limitations will be further addressed in a separate section by complementing the group-based comparisons with data on farmers' and aggregators' actual transactions with WFP-linked buyers and using an instrumental variables regression framework (Section 6).

Furthermore, since WFP operated exclusively through the conditional contracting modality, we are unable to disentangle the specific effect of conditionality from the broader impact of engagement with a large, stable buyer. This is an important and policy-relevant limitation. Consequently, this study examines the combined effect of exposure to a significant institutional buyer operating under a bundled conditional contracting approach.

Survey data were collected on general household characteristics of farmers and aggregators, including welfare and food security indicators. The primary focus, however, was on marketing behavior. We gathered detailed information on farmers' maize sales following both the first and second agricultural seasons of 2023, and on maize cultivation during the first and second season of 2023 and the first season of 2024. For aggregators, data was collected on both purchase and sales transactions for the first and second season of 2023. Additional data was gathered on actors' core business activities: for farmers, this included agricultural technology use and labor inputs; for aggregators, this encompassed handling and storage practices, as well as access to finance.

5 Descriptive Analysis

5.1 Reliable output markets

One of the main reasons why WFP initiated the indirect conditional contacts modality (and local and regional procurement modalities more in general) is the assumption that linking smallholder farmers to a large credible buyer creates a reliable and predictable market for them. Indeed, output market uncertainty has been found to be a key constraint to smallholder market participation, which in turn discourages investment in commercial agriculture and intensification (Barrett, 2008b). Furthermore, the presence of a reliable market does not only affect producers. Van Campenhout, Minten, and Swinnen (2021) find that Foreign Direct Investment in various large dairy processing plants in southwester Uganda created a reliable market for raw milk that led to upgrading across the entire value chain. In this section, we trace this impact pathway by first testing if the LRFPP is correlated to market participation. We then look for associations between WFP procurement activity and investment in technologies

[2] From group 2, approximately 23% reported selling directly to WFP or through a connected aggregator/trader. Among spillover farmers (group 3), this figure is about 12%. In contrast, no farmers in control areas reported any sales to WFP.

Table 2: market participation

	Control	Spillover	Indirect
	sold (yes/no) (%)		
Season 23A	85	94	96
Season 23B	81	92	94
	quantity sold (kg)		
Season 23A	1639	1483	2199
Season 23B	1476	1449	1661
	share sold (%)		
Season 23A	63	66	72
Season 23B	68	73	75

and practices. Finally, we look at some production related outcomes.

5.1.1 Market participation

We find that 91 percent of farmers make at least one sales transaction in the first season of 2023, while this figure is 89 percent in the second season of 2023. The top panel of Table 2 shows how this differs between the three groups of farmers in our sample. In both seasons, while about 85 percent of farmers sell to the market in the control areas, this is closer to 95 percent in the indirect contract group. This suggests that the policy is correlated with increased market participation.

We also find significant differences in quantities sold. For instance, we find that quantity sold is higher in the indirect contract group than in the control group, significantly so in the first season (p-value = 0.067). However, quantities sold are similar in control and spillover groups. In fact, in the first season of 2023, quantities sold are actually lower in the spillover group than in the control group, but the difference is not significant (p-value = 0.458).

Finally, the table also shows quantities sold as a share of quantities produced to arrive a measure for marketable surplus. While it is not clear that the marketable surplus is higher in the spillover group than in the control group, the surplus clearly dominates in the indirect conditional contract group.

Our stack survey allows us to also look at market participation patterns at the aggregator level. To check if the intervention led to aggregators entering the market, we asked how many other maize buyer/aggregators/traders operate in the areas where the aggregator usually collects maize. We find that on average, there are about 6.41 other aggregators working in the control area. This is 9.23 in areas where the policy is implemented, and the difference is significant (p-value = 0.002). This seems to suggest that the policy is positively related to competition among aggregators.

Overall, the findings suggest that the presence of WFP's indirect conditional contracting policy is associated with increased farmer engagement in maize markets. Market participation rates are notably higher in the treatment group compared to control areas, and farmers exposed to the policy tend to sell larger quantities, particularly in the first season of 2023. Moreover, the marketable surplus is clearly higher in the indirect contract group, indicating stronger commercialization incentives. While spillover effects on quantities sold and surplus are less consistent, there is no evidence of a negative impact. At the aggregator level, we observe significantly more active maize buyers in areas where the policy is implemented, pointing to increased competition in local aggregation—an important mechanism through which the policy may be improving market access and outcomes for farmers.

5.1.2 Adoption of technologies

We next test if reliable market access crowds in modern agricultural technologies such as improved seed varieties and fertilizer. For the sake of space, we investigate this only for the first season of 2023.[3] Results of adoption by different groups are summarized in Table 3.

A first outcome we look at is the use of chemicals. Use of pesticides, herbicides and fungicides is relatively high in Uganda. Most farmers use pesticides against fall armyworm and maize stem borers. We see that in the control group, just under 60 percent of farmers are using some kind of chemical on a randomly selected maize plot.[4] This is slightly lower in the indirect and spillover groups. It may be that stricter quality standards refrain farmers from using excessive amounts of chemicals.

Next, we look at use of improved maize seed varieties obtained from a trusted source (as opposed to farmer saved seed). Adoption of improved seed varieties is in line with expectations. In the control group, 39 percent of farmers indicate that they are using improved seed varieties on the randomly selected plot. This increases to 48 percent for spillover farmers and 58 percent for farmers for the indirect contract group. This suggests that WFP's procurement policy is positively associates with the adoption of improved seed varieties.

The picture for fertilizer use is mixed. First of all, Figure 3 illustrates that farmers in Uganda are not in a habit of using fertilizer. Only about 10 percent of farmers apply DAP and organic fertilizer, and this does not seem to be correlated to exposure to the policy, either directly or indirectly. For Urea, we do see that for farmers that live in areas affected by the policy, adoption improves substantially.

[3]The formal analysis in Section 6 presents results for both seasons.

[4]We did not ask about adoption on all maize plots, but instead asked farmers to enumerate all plots and then randomly selected one plot on which detailed questions on technology adoption were asked. This is done to save costs, as we expect that inputs and practices used on plots are highly correlated within households, so surveying more plots does not yield a lot of new information. As the plot was chosen randomly, plot level outcomes provide an unbiased estimate for household level outcomes.

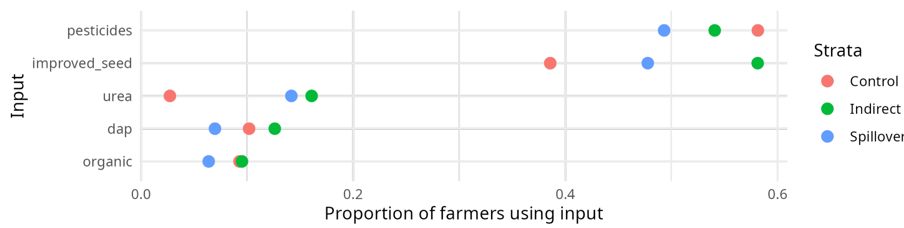

Figure 3: Adoption of agricultural inputs

Overall, the results suggest that WFP's procurement policy is positively associated with the adoption of improved technologies, particularly improved seed varieties. While fertilizer use remains low and chemical use slightly declines—possibly due to stricter quality standards—improved seed adoption increases notably in treatment areas. Given the strong link between seed quality and yield, this is likely the most important channel through which the policy boosts marketable surplus.

5.1.3 Production

Finally we test if the policy also leads to changes in terms of production. We start by testing if farmers that are likely to be affected by the policy, either directly or indirectly, are more likely to cultivate maize, and if so, if they allocate a larger area to maize production. Table 3 illustrates both the propensity to produce and the area under cultivation in three seasons. For example, in the first season of 2023, approximately 94% of the farmers who were directly exposed to the policy cultivated maize. In comparison, only 88% of farmers in the control group did so.

It is important to acknowledge that these figures may be somewhat inflated due to the inclusion criterion that required farmers to have cultivated maize in at least one season. Nonetheless, the key point is the observed distinction between the control group and those in the spillover and indirect contracting groups. Over time, even as the overall proportion declines, the data increasingly indicate that farmers influenced by the policy are more likely to continue growing maize.

The table also shows that area planted seems to be larger in locations that are exposed to indirect conditional contracting. For instance, while the average area planted with maize is about 2.7 acres in the first season of 2023 for treatment and spillover farmers, this is only 2.3 acres for control farmers.

Next, the table turns to production. We see a sharp reduction in production in the first season of 2024. This was caused by erratic rainfall, where it rained early but stooped, causing seeds to not germinate and farmers needed to replant. For the remainder of the season, there was inadequate rain until the critical stage of tasseling. In the first season of 2023, we get the expected pattern where lowest average production is found in the control areas and highest production in the

Table 3: Production related outcomes

	Control	Spillover	Indirect
	produce (yes/no) (%)		
Season 23A	88	93	94
Season 23B	81	90	89
Season 24A	62	83	84
	plot size (acres)		
Season 23A	2.3	2.4	2.7
Season 23B	2.4	2.2	2.5
Season 24A	2.2	1.9	2.2
	production (kg)		
Season 23A	1872.1	1939.3	2313.5
Season 23B	2021.1	1897.5	2351.7
Season 24A	889.5	876.9	964.2
	yield (kg/acre)		
Season 23A	723.7	800.3	806
Season 23B	725.8	842.9	870.7
Season 24A	362.5	444.1	440.6

indirect conditional contract subgroup. In the second season of 2023 average production in the control area is slightly higher. However, in all seasons, largest quantities are produced in the indirect conditional contract group.

Combining plot size and production to obtain yields, we find that overall yield reductions in the first season of 2024 are substantial, but mitigated somewhat by the reduction in plot size. We now also find that average productivity in the control group in is lowest in across seasons. Yields in the spillover and indirect conditional contract groups also seem similar.

Overall, the policy appears to influence production decisions, with farmers in treatment and spillover areas more likely to grow maize and to allocate larger areas to its cultivation. In the first season of 2023, maize production was most widespread and intensive among farmers in the indirect contract group. Yields and total production follow a similar pattern, with consistently higher output in treatment areas across seasons—despite weather-related losses in 2024. These results suggest that the policy not only boosts market participation but also encourages sustained and scaled-up maize production.

5.2 Commodity flows

The previous section showed that WFP procurement areas were associated with increased production and higher volumes handled. In this section, we take a closer look at commodity flows within the value chain. Specifically, using aggregator level data, we examine how the origin and destination of traded maize differs between groups.

We asked aggregators to report the origin of their purchases as a share of total volume. Similarly, aggregators were also asked to indicate the distribution of their sales across different buyer types, expressed as percentage shares. This information is summarized in Figure 4.

The figure illustrates that the majority of maize procured by aggregators—approximately 65 percent—comes directly from farmers, with this share being consistent across both groups. Fellow aggregators also represent a significant source, with a slightly higher share observed in areas where WFP is active compared to the control group (24 percent versus 20 percent). In addition, aggregators operating in areas where the policy was implemented source more maize from markets than their counterparts in control areas, while the volume procured from cooperatives is three times higher in WFP procurement areas than in control areas. Qualitative insights suggest that this difference may stem from the policy's requirement for farmer registration, a process that is often more straightforward when dealing with cooperatives, which typically maintain farmer registries.

At the downstream side, most maize is sold to wholesalers not linked to WFP. In areas where WFP is active, a similar share is also sold to other downstream traders. Notably, in control areas, a large portion of sales is recorded under "other buyers"—a residual category used when reported shares did not sum to 100 percent. As expected, aggregators in control areas rarely sell to WFP, either directly or through WFP-affiliated wholesalers. In contrast, approximately 10 percent of maize traded in the treatment areas is supplied to WFP.

Overall, the findings show that while most maize continues to be sourced directly from farmers across all areas, the presence of the WFP policy is associated with notable shifts in both sourcing and sales patterns. Aggregators in treatment areas source more from markets and cooperatives—likely due to registration requirements—and sell a measurable share (around 10%) to WFP, either directly or indirectly. This suggests that the policy not only affects production and volumes handled but also reshapes upstream and downstream linkages within the value chain.

5.3 Price margin analysis

Central to many value chain studies is the question of how rents are distributed across the different value chain actors. A convenient way to illustrate this is by price spread plots, that plot prices received by the actor upstream (eg the farmer) against prices received by the actor downstream (eg the aggregator). One can then plot a 45 degree line, were prices paid to upstream actors are equal to prices received from downstream actors. As such, points above the 45 degree line represent transactions were the downstream actor earns a positive margin, while points below the 45 degree line are instances where a loss is incurred as commodities are sold at lower prices than at which they were bought.

Figure 5 plots observations for farmer-aggregator transactions in control areas in red, and observations for farmer-aggregator transactions in areas exposed to the policy in green. As can be seen, most points are above the 45 degree line, though there also seem to be occasions where the price at which aggregators (reportedly) bought maize was higher than the price at which they sold. While some of these aggregators may have made a loss, some if it will also be measurement error since it may be hard for aggregators to name a single average price over an entire season.

To deal with over-plotting, we added contour plots with the same color coding to the figure. For the control group, density is highest at points corresponding to a farm gate price of about UGX550 per kilogram of maize and a sales price of about UGX725 per kilogram, leading to an aggregator margin of about UGX175 per kilogram of maize. In other words, in control areas, farmers receive about 75 percent of the price at which aggregators sell onward. For aggregators working in areas where the policy was implemented, density is highest to the southeast of the control density plot. In particular, in these areas aggregators pay about UGX625 per kilogram, while they sell onward at about UGX700, leading to a margin of about UGX125 per kilogram. In these areas, farmers receive about 90 percent of the price at which aggregators sell. Note that compared to the control areas, farmers get more at the farm-gate, while those buying from aggregators pay less. This seems to suggest that value chains are more efficient in areas where WFP is procuring.

We can also combine data at the farmer level with data at the aggregator level to triangulate these important findings. We also split that data by season.

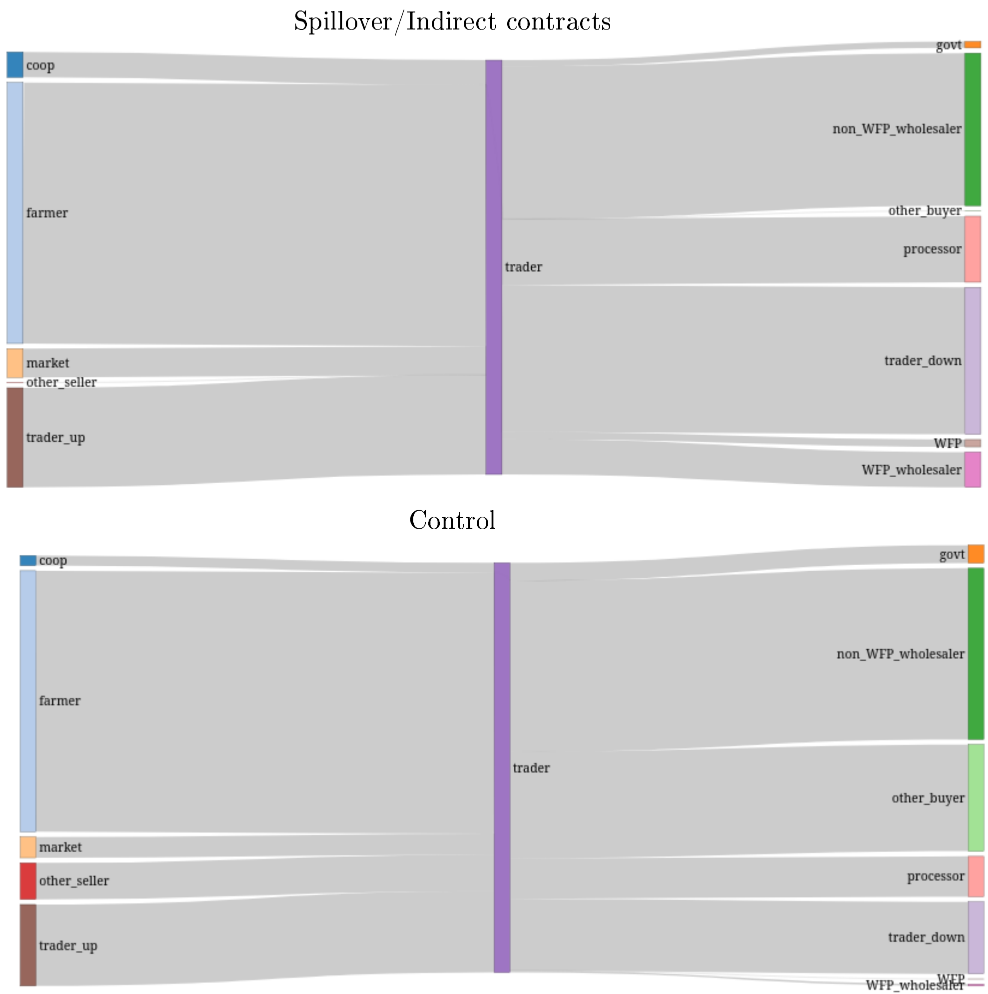

Figure 4: Commodity flows

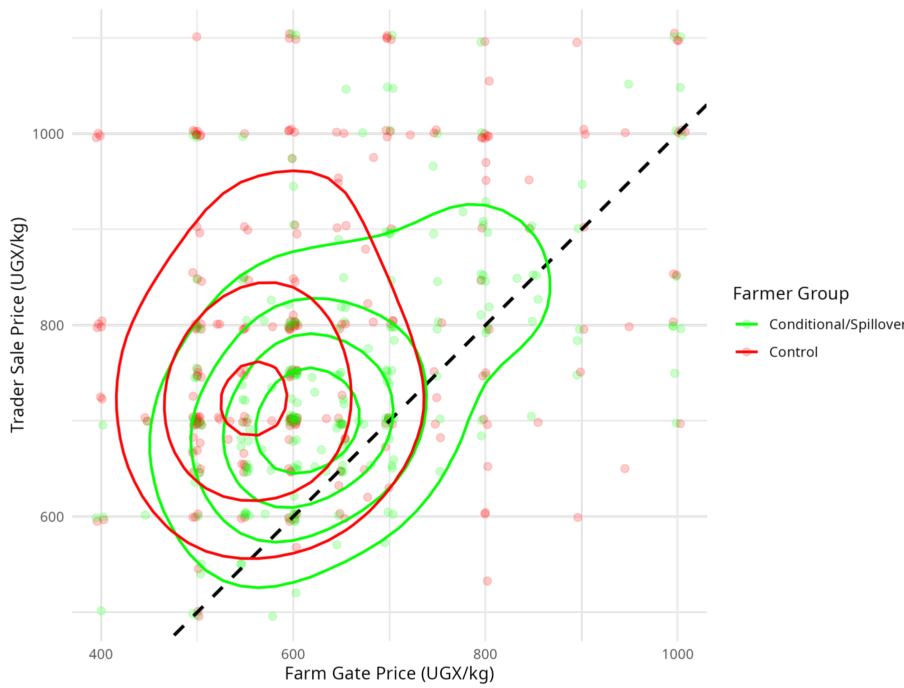

Figure 5: Price margin analysis using aggregator level data

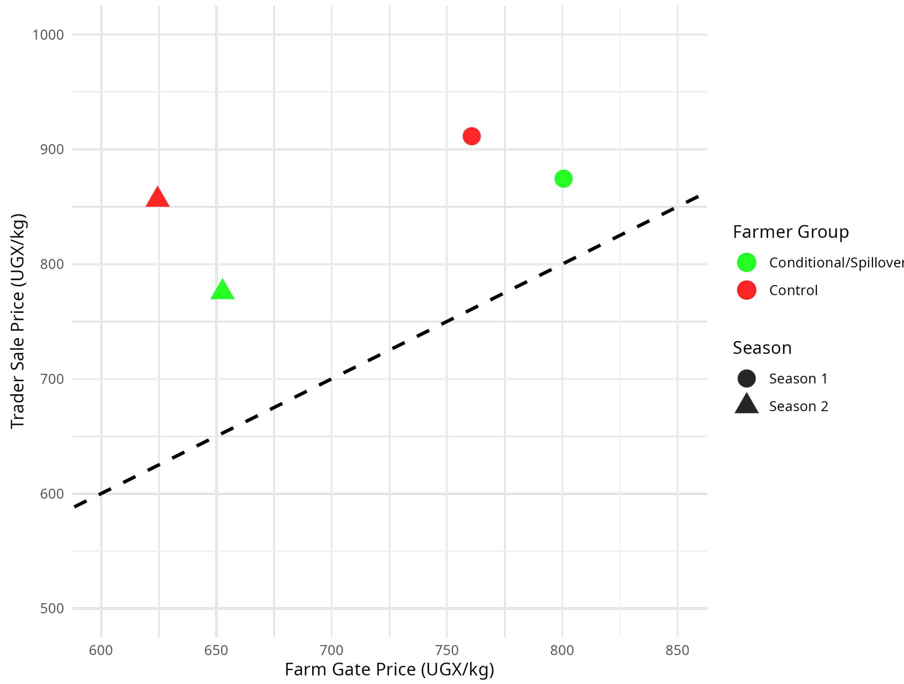

Figure 6: Price margin analysis combining farmer and aggragator level data

Figure 6 confirms that in areas where WFP was active, aggregators capture less of the rents than in control ares, and this is the case in both seasons. For example, in the first season of 2023, farmers sold maize at about UGX800 per kg, while aggregator sold at about 875, implying a pass through of about 90 percent. In the control areas, farmer sell at about 750, while aggregator sell at 900, implying farmers get only about 83 percent of seller prices. We also see that the margin reduces with overall price levels. In the second season of 2023, farmers in the treatment areas sold at 650, while aggregators sold at 775, implying a pass through of 83 percent; in control areas pass through reduces to 73 percent.

The observed increase in farm-gate prices may reflect the direct effect of higher prices and volumes offered by a large, credible buyer like WFP. However, this is accompanied by a notable reduction in the prices at which aggregators sell maize onward. One possible explanation is that WFP-linked aggregators have limited ability to engage in intertemporal price arbitrage. Because they must meet WFP procurement timelines—likely earlier in the season—they may be forced to sell before prices peak. This constraint on timing could compress margins, particularly in years with strong seasonal price fluctuations, and may partly explain the lower resale prices observed among aggregators operating within the WFP procurement framework.

Another explanation, which is consistent with the higher number of aggregators operating in areas where WFP is active already reported in Section 5.1.3, is that the entry of a large buyer leads to increased competition among aggregators, squeezing margins. To test if competition among aggregators mediates the impact of an intervention on the price received by farmers, we use structural equation modeling, which includes techniques like path analysis and mediation analysis. Mediation analysis helps in understanding how an independent variable (in this case, the presence of a significant buyer) influences a dependent variable (price received by farmers) through a mediator variable (the level of competition proxied by the number of aggregators in the area).

Mediation analysis involves the joint estimation of two regression equations. First, the intervention is regressed on the mediator variable. In a second regression, two explanatory variables are used (the mediator and the intervention indicator) to explain the outcome (in our case the price farmers receive). This allows one to separate the total effect of the intervention into a direct effect (which is the effect of WFP procurement on the farmgate price while controlling for aggregator entry) and an indirect effect (which is the effect of WFP procurement on aggregator entry multiplied by the effect of aggregator entry on farmgate prices while controlling for WFP presence).

We combine aggregator level and farmer level data to run the mediation analysis. To achieve this, we construct a farmer-level measure of competition. This is done by averaging aggregator level indicators of competition, weighted by the inverse distance between each farmer and the respective aggregators.

Running the analysis then at the farmer level gives us a total effect of UGX 54.58 that can be decomposed into a direct effect of UGX 26.69 and a mediated effect of UGX 27.89. For the mediated effect, in the treatment area, there are on average 2 additional aggregators active, and each additional aggregator is associated with a price increase of UGX 13.72. Importantly, only the indirect effect is statistically significant, suggesting that the price gains observed by farmers are driven by heightened competition among aggregators. This aligns with our earlier finding that farmer and aggregator prices move in opposite directions, implying that competition is putting pressure on aggregator margins.

In summary, the WFP procurement policy appears to have made value chains more competitive and efficient. Farmers in intervention areas receive a higher share of the final sales price, while aggregator margins are compressed. Mediation analysis shows this is largely driven by increased competition among aggregators, rather than direct effects of WFP engagement. Overall, the policy shifts value chain rents toward farmers.

5.4 Seasonality

Most farmers typically sell most of their harvest immediately after harvesting. Over time, as stocks dwindle, less maize is brought to the market. During the lean season and especially immediately before the harvest of the subsequent season, more maize is bought than sold. These demand and supply patterns result in seasonal price movements in maize prices.

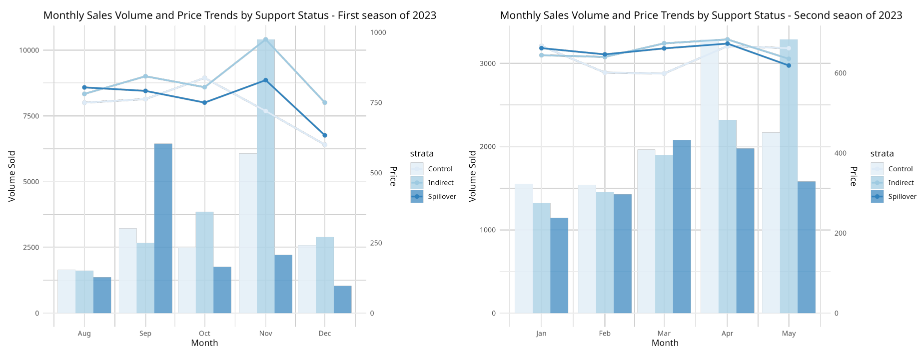

Figure 7: Seasonality in price and volumes

These cyclical price movements can be large, with prices often more than doubling over time. For poor farmers that do not have the capacity to engage in inter-temporal arbitrage, this can lead to so called sell-low buy high patterns, where farmers sell maize at low prices only to buy back similar amounts of maize later in the season at significantly high prices (Burke, Bergquist, and Miguel, 2019). Van Campenhout, Lecoutere, and D'Exelle (2015b) argue that farmers face a double burden: not only do they bear the brunt of price volatility, but they are also likely to have transaction costs passed on to them by aggregators.

An important question therefore is whether the presence of a significant buyer increases or reduces seasonality in prices. If WFP purchases target low prices and writes out tenders immediately post harvest (and potentially distributes food aid during the lean season), its activities could have counter cyclical effects. However, if WFP faces delays in procurement (eg due to administrative reasons) or if aggregators speculate on WFPs purchase, price variation could increase.

Figure 7 uses farmer level data to look at seasonality in volumes entering the market and prices. Interestingly, we do not find that quantities sold are highest immediately after harvest. Especially in the second season, farmers seem to hold on to their maize until April or May. There is some suggestive evidence supporting the hypothesis that farmers areas where WFP is active hold on longer to their maize. For instance, in the first season of 2023, volumes marketed in this group rose steadily to a peak in November. in the second season, the peak is May. Patterns are less clear for the other groups. In the fist season, there is peak among spillover farmers early on in September. In the second season, there is an unusual uptick in sales in April in the control group.

Prices seem to remain fairly stable immediately after harvest. There is a notable increase in prices in the first season of 2023 in November, which is also the month when sales peak in WFP districts. Interestingly, the increase in prices is highest in the group of farmers that are linked to WFP buyers, and lowest in the control group. Overall, and in both seasons, prices reported by farmers that are directly linked to WFP are generally higher. This seems to suggest

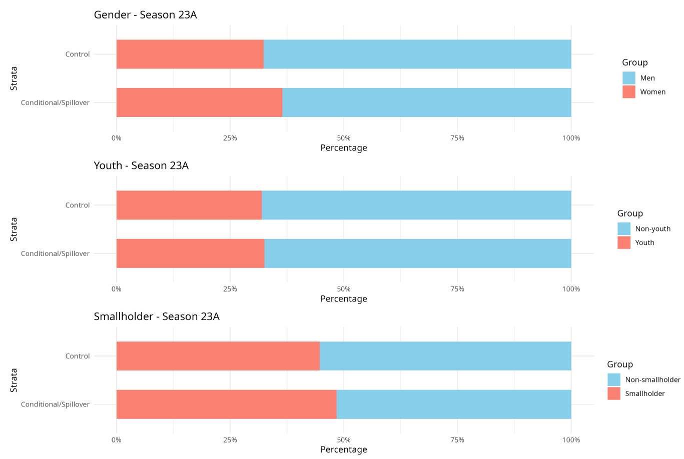

Figure 8: Gender, age and scale of farmer bought from

that WFP purchases indeed led to some degree of price inflation.

In summary, while maize prices typically follow a seasonal pattern driven by harvest and lean periods, the presence of WFP appears to alter this cycle. Farmers in WFP-linked areas seem to delay sales, possibly in anticipation of higher prices, and ultimately receive better prices than those in control areas. This suggests that WFP procurement may increase farm-gate prices but could also contribute to price inflation, depending on timing and market expectations.

5.5 Inclusivity

An important concern raised by WFP is whether the benefits arising from their procurement reach vulnerable groups, such as women and youth. Additionally, one of the core objectives of the policy is to ensure that smallholder farmers are able to benefit from WFP's procurement activities. In this section, we examine whether the impact differs across groups, with a particular focus on farm-gate prices as the key outcome variable.

To assess inclusivity, we asked aggregators to estimate the proportion of their farmer-suppliers who are women, youth, and smallholders. As shown in Figure 8, approximately 30 percent of sellers are women, with a slightly higher share observed in areas where the policy is implemented. A similar share of sellers—around 30 percent—are classified as youth, with little variation between treated and comparison areas. Regarding smallholder farmers, aggregators report a notable difference: in areas where the policy is in place, nearly half of the sellers are smallholders, suggesting that the intervention may be enhancing participation among this target group.

5.6 Food and nutrition insecurity, coping

To look at food security, we use the **Food Insecurity Experience scale (FIES)** questions that refer to the experiences of the individual respondent or of the respondent's household as a whole. The questions focus on self-reported food-related behaviors and experiences associated with increasing difficulties in accessing food due to resource constraints.

Figure 9 compares food insecurity status across treatment groups for two populations—farmers (left panel) and aggregators (right panel). Among farmers, food insecurity is notably higher in the Indirect and Spillover groups compared to the Control group. While a majority of farmers across all groups are food secure, the proportion is highest in the Control group, and declines in both Indirect and Spillover groups. These two treatment groups also exhibit slightly higher proportions of moderate and severe food insecurity.

In contrast, aggregators display significantly higher overall food security, with over 80% classified as food secure across both the Control and Conditional/Spillover groups. Mild and moderate food insecurity are present but relatively limited, and severe food insecurity is rare. Interestingly, the Conditional/Spillover group shows marginally higher food insecurity than the Control group, though the differences are small. These patterns imply that aggregators, likely benefiting from more stable incomes and market access, are less vulnerable to food insecurity, and the interventions did not produce substantial differences in outcomes for this group.

The **Household Dietary Diversity Score (HDDS)** was released in 2006 as part of the FANTA II Project as a population-level indicator of household food access. Household dietary diversity can be described as the number of food groups consumed by a household over a given reference period, and is an important indicator of food security for many reasons. A more diversified household diet is correlated with caloric and protein adequacy, percentage of protein from animal sources, and household income (Swindale and Bilinsky, 2006). The HDDS indicator provides a glimpse of a household's ability to access food as well as its socioeconomic status based on the previous 24 hours (Kennedy et al., 2011). Typically, 0–3 means low dietary diversity very limited access to diverse foods; possible food insecurity. 4–5 Medium dietary diversity Somewhat better access, but still at risk nutritionally. 6–12 High dietary diversity Good access to a variety of foods; better food security.

The left panel of Figure 10 illustrates the distribution of dietary diversity (measured by the number of food groups consumed) among farmers, disaggregated by Control, Indirect, and Spillover groups. The distribution peaks around 6 to 7 food groups for all groups, but the Spillover group shows a higher proportion of individuals achieving 7 or more food groups, suggesting a positive diffusion effect of the intervention on non-directly treated farmers. The Indirect group also shows a slight shift toward higher dietary diversity compared to the Control, indicating that even partial exposure or association with the intervention may have improved nutrition outcomes for farmers.

The right panel focuses on aggregators, comparing those in the Condi-

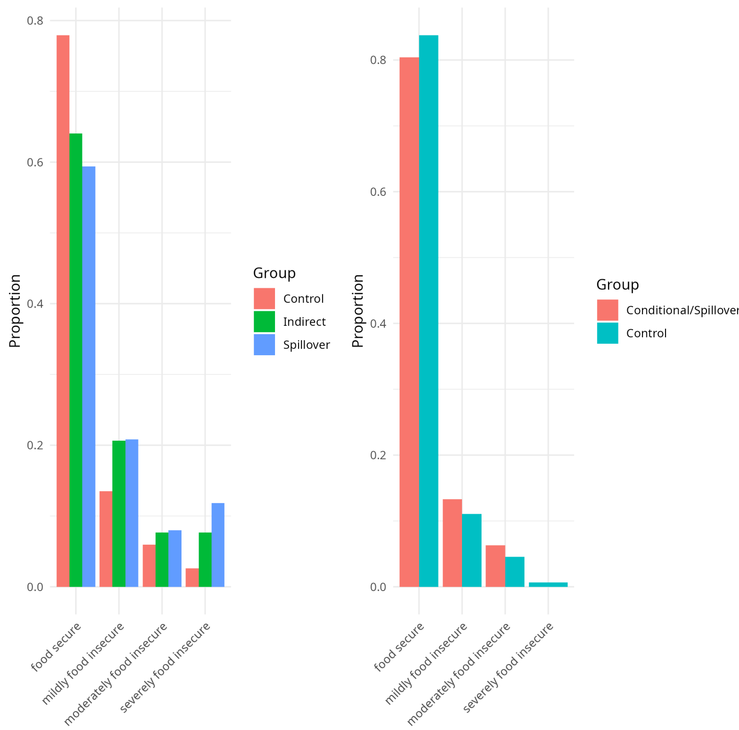

Figure 9: Food insecurity for farmers and aggregators

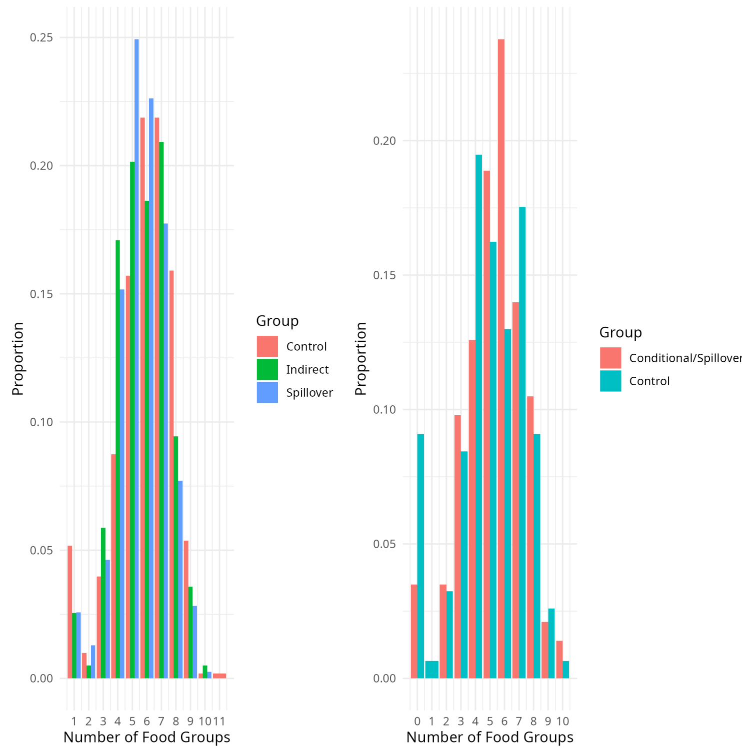

Figure 10: Diet diversity score

tional/Spillover group with those in the Control group. The Conditional/Spillover group displays a notable shift toward higher dietary diversity, with the highest proportion of aggregators consuming around 6 food groups, and a visibly lower proportion consuming fewer than 4 food groups compared to the Control group. This suggests that the intervention had a broader reach, not only affecting participating farmers but also influencing the dietary behavior of aggregators—possibly through increased incomes, improved food availability, or learning effects. Overall, the figure highlights meaningful improvements in dietary diversity among both farmers and aggregators exposed directly or indirectly to the intervention.

The **Livelihood Coping Strategies – Food Security (LCS-FS)** is an indicator used to understand households' medium and longer-term coping capacity in response to lack of food or money to buy food and their ability to overcome challenges in the future. The indicator is derived from a series of questions regarding the households' experiences with livelihood stress and asset depletion to cope with food shortages.

Figures 11 illustrates the severity of livelihood coping strategies among farmers (left panel) and aggregators (right panel), segmented by treatment groups.

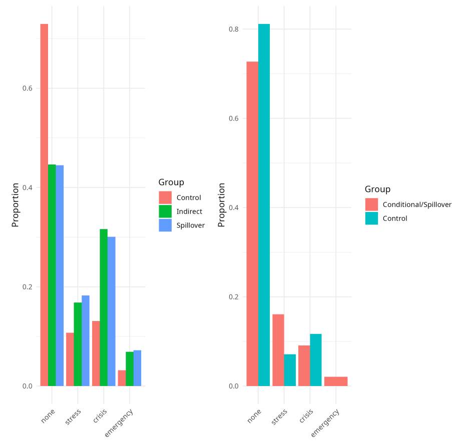

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Figure 11: Livelihood coping strategies

Among farmers, a lower proportion of households in the Indirect and Spillover groups report using no coping strategies compared to the Control group, indicating higher stress. These groups also show a higher incidence of stress, crisis, and emergency-level coping strategies. Notably, the Indirect group reports the highest share of crisis strategies, while Spillover households show slightly elevated use of emergency strategies. This pattern suggests that food or economic shocks may have pushed these households to adopt more severe strategies, potentially due to limited direct benefits from the intervention or unmet expectations.

Aggregators, shown in the right panel, exhibit a more favorable coping profile, with over 80% of households in the Control group and over 70% in the Conditional/Spillover group reporting no use of coping strategies. However, aggregators in the Conditional/Spillover group demonstrate somewhat greater reliance on stress and crisis strategies compared to the Control group, though emergency strategies remain very low in both. This indicates that while most aggregators are not resorting to harmful coping behaviors, those in the treatment group may still be experiencing marginally more pressure than their Control counterparts—perhaps due to market disruptions or unmet expectations associated with the intervention.

In summary, while aggregators appear largely food secure and resilient, farmers in the Indirect and Spillover groups show signs of greater food insecurity and reliance on negative coping strategies. Dietary diversity improved modestly across both farmers and aggregators in treatment areas, particularly among spillover groups, suggesting some diffusion of benefits. However, the persistence of food-related stress and coping behaviors among indirectly affected farmers points to uneven gains, highlighting the need to ensure more inclusive and consistent support across all exposed populations.

6 Regression Analysis

In this section, we take a closer look at some of the most striking findings from the descriptive analysis. In particular, we assess whether the observed patterns hold up under more rigorous scrutiny using regression analysis and instrumental variables as an identification methods.

6.1 Prices

We start with the price margin analysis presented in Section 5.3, first looking at the prices received by farmers. Data is at the transaction level and we pool data from 2023A and 2023B. As in Section 5.3, we compare average farm-gate prices between farmers located in areas where WFP implemented indirect conditional contracts (combining both spillover and indirect contract groups) and those in areas where WFP was not active (control areas).

In the first column of Table 4, we show results for a regression equivalent of what is on the x-axis of Figure 6 (but with added controls for the month when transaction took place). It shows that farmers that live in areas where the policy is implemented received about UGX 23 per kg more for the maize they sold than farmers that live in control areas. This is only slightly lower than what we found in Figure 6 where price differences were about 35 UGX in season 1 and 25 UGX in season 2.

While this comparison is informative, it may yield biased estimates due to potential misclassification of farmer exposure. Specifically, some farmers in control areas may in fact supply aggregators that have a WFP connection, while some farmers in WFP-implementation areas may transact with aggregatos who are not linked to WFP. This mismatch between geographic assignment and actual trading relationships can lead to attenuation bias, underestimating the true impact of the intervention. Moreover, the geographic units used for treatment assignment are relatively coarse, and treatment and control households are often located far apart. As a result, differences in prices or market participation may be driven by unobserved spatial variation—such as differences in infrastructure, agroecological conditions, or market access rather than the intervention itself. This geographic heterogeneity further complicates causal interpretation and underscores the need for more granular or behavior-based measures of exposure.

An alternative approach that address these concerns focuses on actual trading relationships rather than geographic assignment. For each transaction, the survey recorded whether the farmer sold directly to WFP or through a WFP-linked aggregator, as opposed to other channels such as non-linked aggregators or processors. Column (2) of Table 4 presents results from a regression comparing prices received by farmers with such links to those without. The estimated price difference is notably larger (approximately 54 UGX per kg), suggesting that self-reported trading relationships may provide a more accurate measure of policy exposure than location-based assignment alone.

While this alternative approach provides a more direct measure of farmer exposure to the intervention, it is also not without problems. Most notably, the decision to sell to WFP or through a WFP-linked aggregators/traders is endogenous and may reflect unobserved characteristics of the farmer or the transaction. For instance, farmers with higher-quality maize, better market information, or stronger bargaining power may be more likely to attract WFP-linked traders and command higher prices, regardless of the intervention. As a result, the observed price premium may reflect selection effects rather than a causal impact of trading with WFP-linked buyers. Depending on the direction of this selection, the estimated price difference could either overstate or understate the true effect of the intervention.

This is why we turn to an instrumental variables approach in Column (3) of Table 4. We use whether the farmer resides in an area where WFP implemented indirect conditional contracts as an instrument for trading with a WFP-linked buyer. This location-based instrument is relevant, as the intervention was explicitly designed to increase such trading relationships in targeted areas. Relevance is also demonstrated by a strong first stage with an F-statistic of 94.38. Under the assumption that geographic implementation affects farm-gate prices only through its impact on trader linkages—and not through other local price determinants—the IV approach isolates the causal effect of selling to a WFP-linked trader.[5] The two-stage least squares estimate suggests that farmers connected to WFP-linked traders received approximately 180 UGX more per kg than those who were not.[6]

In column (4), we add additional controls to the 2SLS of column (3). Controlling for additional variables serves several purposes. First, it helps improve the precision of the estimates by accounting for observable factors that influence farm-gate prices, such as quantity sold and farmer characteristics like education or farm size. Second, including these controls helps mitigate concerns that the instrument (location) may be correlated with other determinants of price beyond the trading relationship. For example, if WFP targeted areas that differ systematically in infrastructure, market access, or farmer capacity, this violates the exclusion restriction. By conditioning on these covariates, we reduce the risk that omitted variable bias distorts our IV estimates and strengthen the credibility of the exclusion restriction. Essentially, the goal is to ensure that the identifying variation in trader linkage is as exogenous as possible, conditional

[5]This assumption may appear to run counter to our earlier analysis, which left open the possibility of spillover effects. To assess this, we conducted a placebo test, examining whether residing in a WFP-implementation area affects the price received by farmers who did not sell to WFP-linked traders. The results indicate that it does not. We also tested whether location has predictive power within the subset of farmers who did trade with WFP-linked traders, and again found no significant effect. Taken together, these findings provide supportive evidence for the validity of the exclusion restriction: the instrument appears to affect prices only through its influence on trading relationships, rather than through alternative pathways.

[6]Unfortunately, the share of transactions with WFP-connected traders is limited. In particular, of the 2,200 transactions recorded, only about 10 percent involve a WFP connection. Because the estimated Local Average Treatment Effect (LATE) is identified only for the subpopulation of compliers, it may not generalize to the broader population of farmers. In particular, if compliers differ systematically from non-compliers (e.g., in market access, risk preferences, or capacity to meet WFP quality standards), the estimated treatment effect may overstate or understate the average impact of WFP connections more broadly.

on observed characteristics.

We include seven control variables. First, we control for the gender, age, and education level of the household head because these variables may proxy for bargaining power, information access, or ability to negotiate with buyers. For instance, more educated farmers may be better informed about prevailing market prices or may be more confident in bargaining. Similarly, male-headed households might be treated differently by traders than female-headed households due to prevailing gender norms (see for instance Van Campenhout and Nabwire (2025) on buyer side discrimination in bargaining in Uganda), while the age of the head could reflect experience or risk preferences (Schildberg-Hörisch, 2018).

Household size is included as it may capture labor availability and subsistence needs, both of which can affect production choices and marketing behavior. Larger households may have more surplus to sell or be under more pressure to sell early in the season (Burke, Bergquist, and Miguel, 2019). Likewise, the total acreage of land owned serves as a proxy for the scale of production and underlying wealth, which are likely to influence not only the volumes marketed but also the bargaining position of the farmer.

Membership in a maize-focused cooperative is included because cooperatives may provide market access, storage facilities, and collective bargaining opportunities, all of which can impact transaction prices. Similarly, controlling for the quantity sold in the transaction helps address concerns that larger volumes may be associated with price discounts or premiums due to economies of scale or buyer preferences. Adding controls further increases the estimate of the impact of policy on the prices farmers receive. Farmers that are connected to WFP linked aggregators get about 260 UGX more than farmers that are not linked to WFP.

Table 4: Effect of WFP connection on farm-gate prices

	Dependent variable: Price			
	Price			
	OLS		*instrumental variable*	
	OLS Exogenous	OLS Endogenous	IV	IV + Controls
	(1)	(2)	(3)	(4)
Strata (instrument)	23.050*			
	(11.781)			
WFP connected (endogenous)		54.195***	180.850*	228.190***
		(15.974)	(93.096)	(88.557)
Male head				−1.337
				(12.971)
Age head				−0.033
				(0.421)
Primary head				15.715
				(10.961)
HH size				−1.685
				(1.799)
Land owned				0.396
				(0.667)
Coop member				−30.696
				(19.571)
Volume sold				0.002
				(0.002)
Month FE	Yes	Yes	Yes	Yes
Strata2 used as instrument	No	No	Yes	Yes
Estimation	OLS	OLS	2SLS	2SLS
Observations	2,210	2,210	2,210	2,099
R^2	0.083	0.086	0.055	0.041

Note: *p<0.1; **p<0.05; ***p<0.01

We run a similar analysis at the aggregator level, focusing on the prices aggregators received when selling maize onward (to WFP directly, to WFP-connected traders, or to other buyers). At this level, we lack detailed transaction-level data. However, for both the first and second seasons of 2023, we collected information on the outlets to which aggregators sold their maize and the shares in total sales going to each type of buyer. Aggregators were also asked to report the prices they received from WFP and non-WFP-connected buyers. We used this information to compute a weighted average price for each aggregator, using the reported shares sold to each buyer type as weights.

In Section 5.3, we also compare prices between aggregators located in areas where WFP implemented indirect conditional contracts and those in control areas where WFP was not active. Column (1) of Table 5 presents the regression counterpart of the y-axis in Figure 6, but now with the addition of season fixed effects. The results indicate that aggregators in treatment areas received, on average, approximately UGX 60 less per kilogram than their counterparts in control areas. This aligns with the visual evidence from Figure 6, which shows that in season A, aggregators in treatment areas received about UGX 35 less than in control areas, with the gap widening to around UGX 75 per kilogram in season B.

Similar to the farmer analysis above, relying solely on an aggregator's location to define exposure to the intervention can be misleading. Aggregators are inherently mobile and often operate across multiple areas, potentially sourcing from farmers in both treatment and control locations. Moreover, not all aggregators based in WFP implementation areas are necessarily connected to WFP-related supply chains. This geographic misclassification blurs the distinction between treatment and control groups, introducing attenuation bias. In addition, aggregators operating in different locations may not be directly comparable. Local market dynamics, transport infrastructure, and crop quality can vary substantially across areas, potentially confounding simple location-based comparisons. This further underscores the need for a more precise identification strategy based on actual trading relationships rather than geographic proxies.

To more directly estimate the effect of WFP connections on the prices received by aggregators, we re-run the analysis using a binary indicator as the independent variable. This indicator equals one if the aggregator sold maize either directly to WFP or to a wholesaler affiliated with WFP, and zero if the aggregator sold to any other type of buyer. The results, presented in column (2) of Table 5, reveal no statistically significant difference in the prices received by aggregators with a direct WFP connection. However, this measure of connectivity is likely to be affected by selection bias. Aggregators linked to WFP may differ systematically from others—potentially operating in surplus-producing areas, being more professionalized, or located closer to procurement hubs. If such characteristics are also associated with lower prevailing prices, the estimated effect of WFP connectivity may be biased downward. At the same time, confounding factors could mask the true effect: aggregators who sell to WFP may also possess traits that help them secure higher prices from other buyers—such as better capital, stronger logistics, or more consistent quality. These traits could partially offset the negative price effect of selling to WFP, making the OLS estimate appear close to zero even if a true effect exists. To address this, we instrument WFP connectivity again using the geographic strata defined during the sampling design. These strata reflect variation in the likelihood that an aggregator is connected to WFP, based on where aggregators were sampled, and provide a source of plausibly exogenous variation for identification.

The parsimonious 2SLS regression reported in column (3) reveals a large and statistically significant reduction in the prices received by aggregators who sell to WFP or to a WFP-connected wholesaler. On average, these aggregators receive nearly 300 UGX less per kilogram of maize compared to those selling to other buyers.[7] In column (4), we extend the specification by adding aggregator-level and transaction-level controls—mirroring the approach used in the farmer-level regressions presented in Table 5. Including these covariates slightly reduces the magnitude of the estimated effect, but the negative and significant relationship between WFP connectivity and aggregator prices persists, reinforcing the robustness of the finding.

[7] Similar to the regression at the farmer level, we find a first stage F-statistic that is substantial, suggesting that the instrument is relevant. We also ran both placebo tests and find that among farmers who did not trade with WFP-linked aggregators, those residing in WFP implementation areas actually received significantly lower prices. Among farmers who did trade with WFP-linked aggregators, location does not significantly predict prices.

Table 5: Effect of WFP Connection on Trader-Level Selling Prices

	Dependent variable: Selling Price (UGX/kg)			
	Price			
	OLS		*instrumental variable*	
	OLS Exogenous	OLS Endogenous	IV	IV + Controls
	(1)	(2)	(3)	(4)
Strata (instrument)	−61.514***			
	(23.355)			
WFP connected (endogenous)		−32.291	−292.875**	−272.461**
		(30.684)	(120.243)	(112.597)
Male head				−148.436**
				(71.429)
Age head				0.964
				(1.984)
Prim head				46.648
				(28.558)
HH size				4.030
				(4.424)
VolumeSold				0.007
				(0.018)
Season FE	Yes	Yes	Yes	Yes
Strata used as instrument	No	No	Yes	Yes
Estimation	OLS	OLS	2SLS	2SLS
Observations	569	569	569	565
R^2	0.043	0.028	−0.101	−0.060
Note:				*p<0.1; **p<0.05; ***p<0.01

In sum, the analysis shows that farmers connected to WFP-linked aggregators receive significantly higher prices—up to 260 UGX more per kg—while aggregators selling to WFP or its affiliates receive substantially less. These results, robust to controls and validated through instrumental variable methods, suggest that the WFP intervention increases farm-gate prices by enhancing market access and competition, but compresses intermediary margins, likely due to timing constraints and procurement pressure. Overall, the intervention appears to shift value chain rents toward farmers.

6.2 Adoption of inputs

Another key outcome we consider at the farmer level is adoption of agricultural inputs. The analysis in Section 5.1.2 suggested that for some inputs (urea and improved seed varieties), the policy seemed to have a positive effect, while use of pesticides seems to be reduced. Instead of running the analysis for each input separately, we combine them in an index following Anderson (2008).

One complication in this analysis is that the measure of WFP connectivity is recorded at the transaction level, while adoption is measured at the farmer level. To address this, we aggregate the transaction-level information by defining a farmer as connected to WFP if they engaged in at least one transaction with a WFP-linked aggregator during the season. If none of their transactions involved a WFP-linked aggregator, the farmer is considered not connected. This approach ensures that our farmer-level connectivity variable captures meaningful exposure to the intervention.

Table 6: Effect of WFP connection on adoption

	Dependent variable: Price			
	adoption_index			
	OLS		*instrumental variable*	
	OLS Exogenous	OLS Endogenous	IV	IV + Controls
	(1)	(2)	(3)	(4)
Strata (instrument)	0.108***			
	(0.027)			
WFP connected (endogenous)		0.175***	0.845***	0.821***
		(0.054)	(0.222)	(0.218)
Male head				0.043
				(0.034)
Age head				−0.003***
				(0.001)
Primary head				0.146***
				(0.030)
HH size				0.015***
				(0.005)
Land owned				0.006***
				(0.002)
Coop member				−0.003
				(0.049)
Month FE	Yes	Yes	Yes	Yes
Strata2 used as instrument	No	No	Yes	Yes
Estimation	OLS	OLS	2SLS	2SLS
Observations	2,226	2,226	2,226	2,129
R^2	0.020	0.019	−0.114	−0.057
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 6 presents the regression results and confirms the patterns observed in Figure 3. Adoption of improved agricultural technologies is significantly higher in areas where the policy is active (column (1)). The estimated effect increases when using the endogenous measure of connectivity as the explanatory variable (column (2)). Instrumental variable regressions further support a positive and statistically significant impact of the policy on adoption outcomes, reinforcing the interpretation that the observed differences are not solely driven by selection or confounding factors.

We also look at inputs at the aggregator level. In particular, we ask if aggregators provide inputs like seed, fertilizer and chemicals and/or a tarpaulin that can be used for drying of maize grains, and check for differences between aggregators that are integrated in WFP supply chains versus those that are note. Results are in Table 7. OLS estimates in column (2) show that WFP-connected aggregators are significantly more likely to invest in inputs (coefficient = 0.310, $p<0.01$), but this relationship may be endogenous. Instrumental variable (IV) estimates in column (3), using geographic strata as an instrument, yield a much larger coefficient (1.131), suggesting that selection bias may downwardly bias OLS estimates. While the IV estimate is only marginally significant due to a larger standard error, the effect remains large and statistically significant at the 5% level in column (4), which includes aggregator-level controls such as gender, age, education, household size, and transaction volume. None of the controls are strongly predictive, though older aggregators are slightly less likely to invest. These findings suggest that WFP's procurement model leads to meaningful changes in aggregator behavior, encouraging investment in input provision.

Table 7: Effect of WFP Connection on Trader providing inputs

	Dependent variable: Invests in quality (1=yes)			
	inputs			
	OLS		*instrumental variable*	
	OLS Exogenous	OLS Endogenous	IV	IV + Controls
	(1)	(2)	(3)	(4)
Strata (instrument)	0.280***			
	(0.056)			
WFP connected (endogenous)		0.310***	1.131***	1.041***
		(0.070)	(0.270)	(0.291)
Male head				0.406***
				(0.068)
Age head				−0.006
				(0.004)
Prim head				−0.065
				(0.069)
HH size				0.008
				(0.012)
VolumeSold				−0.00002
				(0.00001)
Strata used as instrument	No	No	Yes	Yes
Estimation	OLS	OLS	2SLS	2SLS
Observations	297	297	297	281
Note:				*p<0.1; **p<0.05; ***p<0.01

In summary, the analysis shows that WFP's intervention significantly boosts the adoption of agricultural inputs by both farmers and aggregators. Farmers in WFP-linked areas are more likely to adopt improved technologies, with IV estimates confirming this effect is not solely due to selection. Similarly, WFP-connected aggregators are substantially more likely to provide inputs, and IV results suggest that OLS underestimates this effect due to downward bias. Together, these findings indicate that the policy not only improves market access but also encourages complementary investments that support higher productivity.

6.3 Investment in quality

At the aggregator level, we assess investment in quality by constructing a binary indicator that captures consistent adherence to key post-harvest practices. Specifically, an aggregator is coded as investing in quality if they always dry their maize, always measure moisture content, grade the maize, and clean it using either a screen/sieve or a mechanical cleaner. This composite measure captures a holistic approach to quality management, emphasizing both the physical condition of the maize and the consistency of practices across transactions. By requiring that all these conditions be met, the indicator reflects a sustained and deliberate investment in quality rather than occasional or partial compliance.

Table 8 shows the by now familiar table with OLS and 2SLS results. The OLS regression in column (2) finds no significant relationship between WFP connectivity and quality investment (coefficient = 0.030), suggesting that simple correlations may underestimate the true effect. However, once endogeneity is addressed using strata as an instrument in a 2SLS framework (column (3)), the estimated effect increases substantially to 0.506 and becomes statistically significant at the 1% level. This effect remains robust and slightly increases (to 0.590) after including controls for aggregator demographics and transaction volume in column (4), with significance maintained at the 5% level.

Table 8: Effect of WFP Connection on Trader-Level Quality Investment

	Dependent variable: Invests in quality (1=yes)			
	qual			
	OLS		*instrumental variable*	
	OLS Exogenous	OLS Endogenous	IV	IV + Controls
	(1)	(2)	(3)	(4)
Strata (instrument)	0.125***			
	(0.041)			
WFP connected (endogenous)		0.030	0.506***	0.590***
		(0.059)	(0.187)	(0.219)
Male head				0.102
				(0.212)
Age head				0.001
				(0.003)
Prim head				0.096**
				(0.049)
HH size				0.012
				(0.010)
VolumeSold				−0.00001
				(0.00002)
Strata used as instrument	No	No	Yes	Yes
Estimation	OLS	OLS	2SLS	2SLS
Observations	297	297	297	281

Note: *p<0.1; **p<0.05; ***p<0.01

7 Conclusion and Policy recommendations

This study set out to assess the impact of indirect conditional contracts implemented by the World Food Programme (WFP) in Uganda, with a specific focus on their role in transforming the maize value chain. Our analysis was guided by four core research questions: (1) What is the impact of the conditional contract on key outcomes—price realization, amount sold, household income and other welfare indicators—of actors along the value chain, especially for smallholder farmers and small maize aggregators? (2) Do conditional contracts create access to reliable markets and result in value chain transformation or upgrading? (3) Does the presence of a formal/institutional buyer in an area (e.g. a WFP-affiliated aggregator or contract scheme) indirectly improve outcomes for nearby smallholders and aggregators who are not directly contracted? (4) What are the challenges or barriers faced with respect to conditional contracts?

To answer these questions, we collected rich, stratified data from over 1,300 farmers and nearly 300 aggregators from six districts in Western and Central Uganda. Stratification was done conditional on how farmers and aggregators were likely to be exposed to the indirect conditional contract programme. In a first group, farmers that were connected to a WFP buyer are included. In a second group, we interviewed their neighbors. A third group was in a district where WFP was not active. For aggregators, we only differentiated between those working in areas where WFP is active versus districts where they are not. We then attempt to learn about the impact by comparing the groups. We applied both descriptive and econometric techniques—mediation analysis and instrumental variables regression—to disentangle the effects of the procurement policy from other factors.

The analysis provides robust evidence that WFP's indirect conditional contracting policy significantly reshaped maize market dynamics in the targeted areas. One of the clearest impacts is the increased market participation and production intensity among farmers. The intervention encouraged more farmers to grow maize and to allocate larger portions of land to its cultivation, with consistent increases in output observed across seasons. This expansion in production was supported by a notable rise in the adoption of improved technologies—particularly improved seed varieties—which are strongly linked to productivity gains. While fertilizer and pesticide use remained relatively low or declined slightly, likely due to cost or compliance with WFP quality standards, the seed adoption effect stands out as a key channel through which the policy boosted marketable surplus.

The intervention also had measurable effects on upstream and downstream linkages within the value chain. Aggregators in treatment areas reported sourcing more from markets and cooperatives, which may reflect the procedural requirements of the policy (e.g., farmer registration). Additionally, around 10 percent of maize handled by aggregators in these areas was sold to WFP either directly or via affiliated wholesalers. This change in sourcing and sales patterns indicates that the intervention not only affected production volumes but also altered how maize flowed through the value chain, with implications for traceability and formalization.

One of the most important findings concerns price transmission. Farmers in WFP-linked areas received significantly higher prices—up to 260 UGX more per kg—while aggregators operating within WFP supply chains received substantially less. Mediation analysis shows that this shift in value chain rents was primarily driven by increased competition among aggregators, suggesting that the intervention enhanced market efficiency. Furthermore, WFP presence appears to influence seasonal marketing behavior, with farmers in treatment areas delaying sales to take advantage of better prices. While this can support higher incomes, it may also contribute to price inflation, depending on procurement timing and market expectations.

The policy also spurred complementary investments. Farmers in intervention areas adopted a broader range of inputs, and aggregators connected to WFP were significantly more likely to provide inputs such as seed, fertilizer, or drying tarpaulins to suppliers. Similarly, investment in quality assurance practices—such as drying, grading, and moisture measurement—was significantly higher among WFP-linked aggregators once endogeneity was accounted for. These complementary investments suggest that the intervention has not only improved immediate market access but also contributed to upgrading value chain functions in ways that could support long-term productivity and resilience.

In terms of inclusivity, the intervention appears to have increased participation among smallholder farmers, with aggregators in WFP areas reporting a significantly higher share of smallholder suppliers. While the shares of women and youth involved in trading relationships remained relatively stable across groups, the evidence does suggest some positive movement toward the inclusion of the policy's target populations. However, food security outcomes remain mixed. While aggregators appear largely food secure, farmers in treatment areas—particularly those in the indirect or spillover groups—continue to report higher levels of food insecurity and greater reliance on negative coping strategies. These findings highlight the need for continued attention to equitable distribution of benefits, particularly for indirectly exposed populations who may face unmet expectations or barriers to full participation.

Overall, the WFP procurement policy has demonstrated clear potential to strengthen agricultural markets, improve producer prices, and stimulate investment in both input use and quality management. However, the benefits are not uniformly distributed, and the persistence of food insecurity and coping among certain farmer groups points to the need for more inclusive support mechanisms. Future iterations of the policy could focus on improving reach and accessibility for the most vulnerable farmers, while continuing to build on the successful elements of market integration and value chain upgrading that this analysis has highlighted.

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